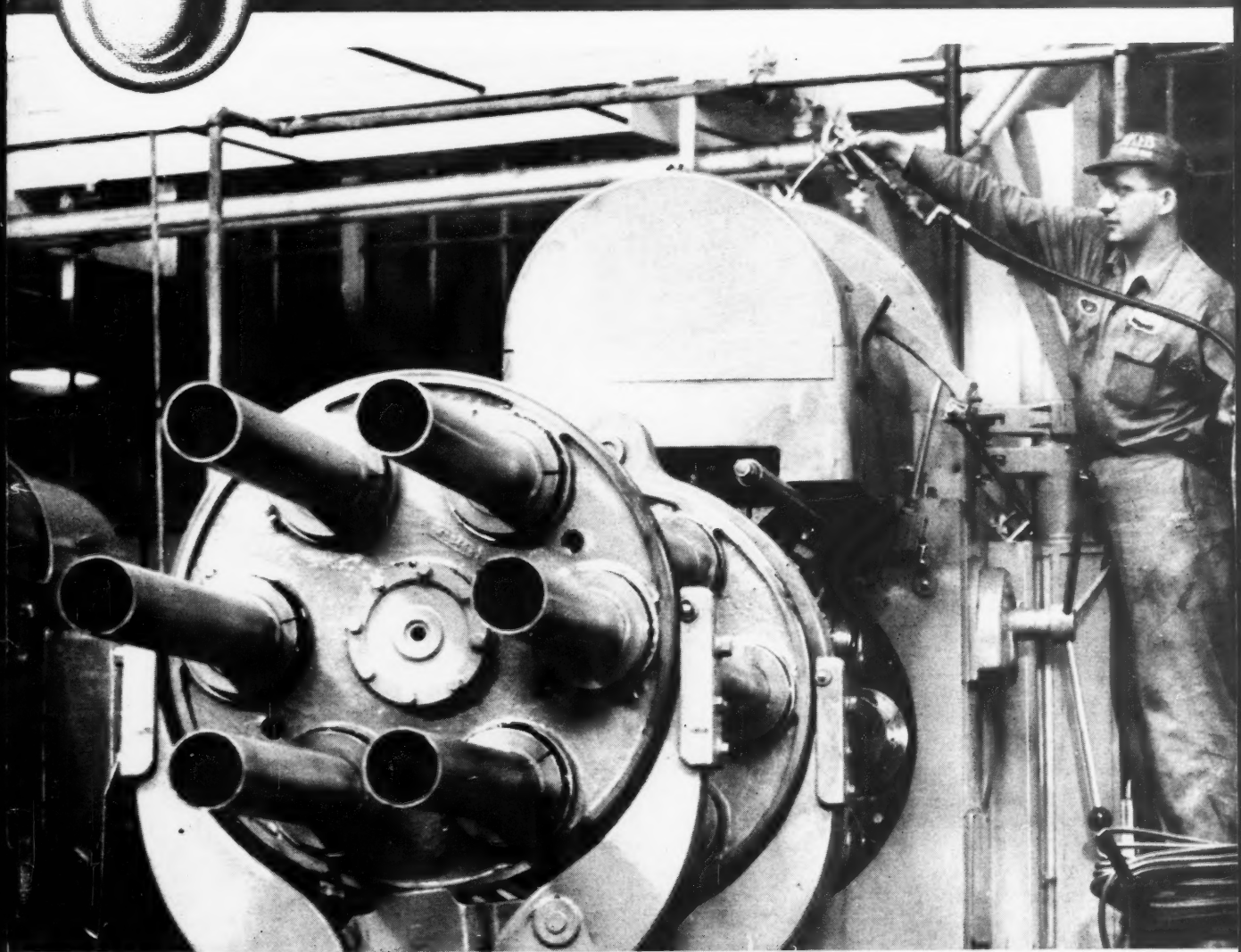
MAY-JUNE, 1954
Vol. 10, No. 3

Lubrication ENGINEERING



Practical Feature: PLANNED LUBRICATION SAVES CADILLAC MONEY

JOURNAL OF
THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

OVER

20,000

BEARINGS ARE LUBRICATED AT FAIRLESS WORKS BY

Trabon

LUBRICATION SYSTEMS

PHOTOS COURTESY U. S. STEEL CORPORATION

The following wide range of equipment at U. S. Steel's new Fairless Works is lubricated around the clock by TRABON *positive* lubrication systems: Wellman Ore Bridge; E. W. Bliss Hi Scale Breakers; Arthur G. McKee Blast Furnaces; Atlas Ore Transfer Cars; Wean Combination Line; Alliance Cranes; Cleveland Cranes; American Bridge Cranes; Wellman Charging Machines; Dravo Ore Unloaders; E. W. Bliss 80″ Pickle Line; Mesta 45″ Slabbing Mill; Mesta 80″ Hot Strip Mill; Morgan 10″ Merchant Mill; Continental 40″ Blooming Mill; United Billet Mills; Morgan Scale Yard Crane; E. W. Bliss Cold Mills.

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Oil and Grease Systems

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Membership in the American Society of Lubrication Engineers is in several grades as defined below. Assignment to grade is made by the Admissions Committee or Board of Directors on the basis of information submitted or supplied by references.

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For application blanks or further information, write:

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84 E. Randolph St.
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Lubrication ENGINEERING

May-June, 1954, Vol. 10, No. 3

TABLE OF CONTENTS

Planned Lubrication Saves Cadillac Money (Practical Lubrication, No. 13) by A. C. McKeen 140
Surface Active Rust Preventives In Lubricating Oil by D. W. Criddle 143
Laboratory Evaluation Of Metal-Forming Lubricants by R. S. Barnes & T. H. Cafcas 147
Lubrication Systems For Heavy Closed Die Forging Presses by W. J. Polny & R. G. Sturm 151
Early Stages Of Fretting Of Copper, Iron & Steel by D. Godfrey & J. M. Bailey 155
ASLE Progress Report For 1953-1954 by W. E. Campbell 162
Advertisers' Index 176
ASLE Directory 161
ASLE Officers & Directors for 1954-1955 160
Conference on Lubrication Hi-Lites 136
Current Literature 150
Lube Lines (includes President's Message and Annual Meeting Hi-Lites) 137
Lubrication in the News 142
Meet the Authors 139
Patent Abstracts 146
Personals 154
Section News 159

(Cover Picture courtesy of Cadillac Motor Car Div., GMC)

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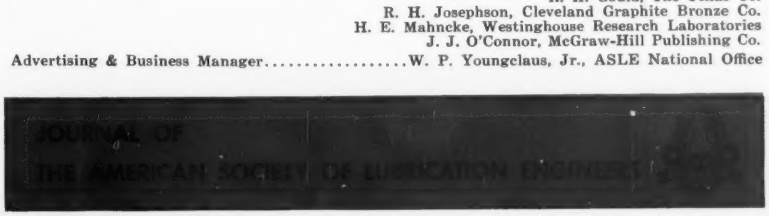
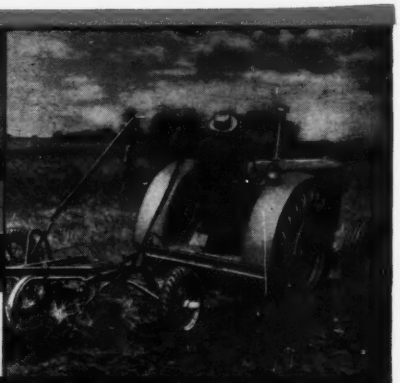


One instead of many greases saves labor and time . . . reduces grease inventory and grease gun equipment.

Mechanical stability, water resistance, and excellent adhesion keeps Inlucite 21 in shackles and bearings longer.



Excellent pumpability at extreme temperatures, durability and water resistance affords protection under all conditions.

Users Cut Operating Costs With

INLUCITE 21

The unexcelled multi-purpose Lithium base lubricant

Inlucite 21 is economical to use because only one grease gun is needed . . . this versatile, unexcelled multi-purpose lubricant can be handled in all types of dispensing equipment.

Inlucite 21 is economical to use because only one container of grease is needed . . . lubricate chassis, wheel bearings, universal joints and water pumps with this one premium lubricant, superior in performance and durability to the specialized greases that it replaces.

Inlucite 21 is economical to use because it's an all-weather lubricant that pumps readily even at zero temperatures.

Inlucite 21 is made under our exclusive patented process.

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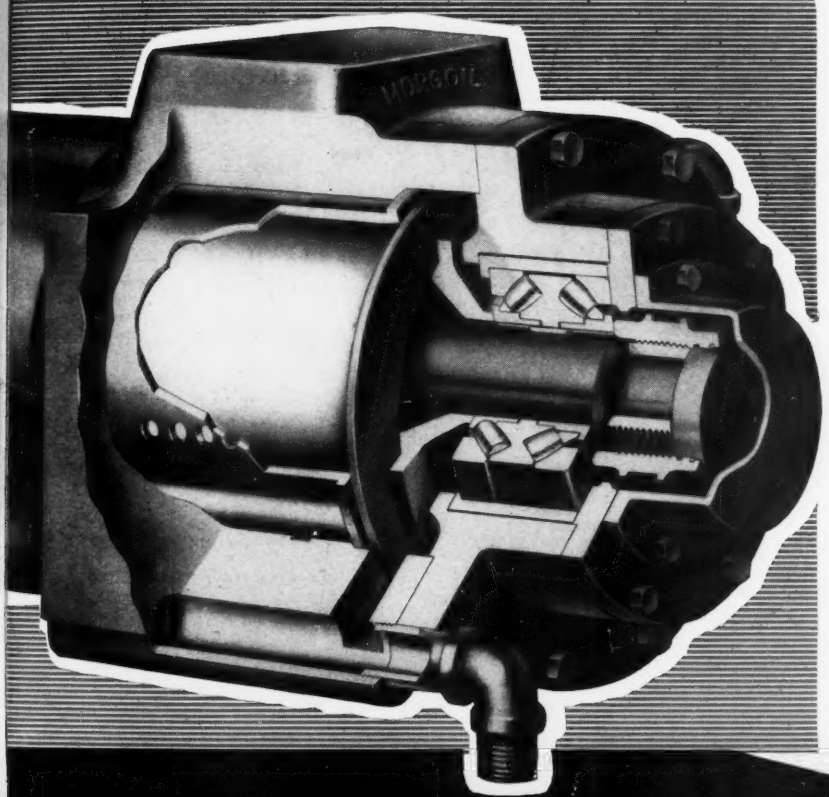
New Orleans, Louisiana
Manufacturers of Quality Lubricants
AVIATION · INDUSTRIAL · AUTOMOTIVE · MARINE

With Research Comes Quality,
With Quality Comes Leadership.

Morgoil Adopts Aluminum Alloy

IN 1935, Morgan Construction Company, ever on the alert for improvements in roll neck bearings, was a pioneer in the use of cadmium nickel alloys to replace babbitt as the bearing metal in MORGOIL Bearings.

World War II interrupted our research program but **IN 1946** we turned our attention to aluminum alloy bearing metals. For six years we carried on an extensive investigation in co-operation with the Research and Development Division of the Aluminum Company of America. Aluminum alloy bushings were tested in MORGOIL Bearings on all types of 2-high and 4-high mills in the plants of many of our customers and have definitely proved their superiority under the most grueling of operating conditions. **IN 1952** our production of bushings was changed to the aluminum alloy type. We are confident that this marked another important milestone in the development of the most rugged, most dependable and most economical roll neck bearing — MORGOIL.



•

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ROLLING MILLS - MORGOIL BEARINGS
WIRE MILLS - GAS PRODUCERS - AIR EJECTORS
REGENERATIVE FURNACE CONTROL

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MB-25

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ROLL NECK BEARINGS

AT WRIGHT AERONAUTICAL*

just one grease

SHELL ALVANIA GREASE

lubricates

3,200 MACHINE TOOLS
25,600 ELECTRIC MOTORS

and reduces grease requirements 15%

**Engine Division of Curtiss-Wright Corporation*

ALONG with progressive companies in every industry, the Engine division of Curtiss-Wright has found that a single lubricant, Shell Alvania Grease, provides superior protection to many different kinds of machines . . . from sump pumps to compressors to forging presses. They discovered at the same time the considerable economy of greatly reduced grease inventory . . . just the *one* grease for hundreds of machines.

In plant after plant, Shell Alvania Grease provides superior lubrication for every grease-lubricated machine in the place!

Look at these advantages:

1. **Shell Alvania Grease flows *freely* in cold temperatures, yet will not run out of bearings under excessive heat.**
2. **Ideal for wet, humid applications . . . it resists water emulsification.**
3. **Shell Alvania Grease has extremely high oxidation stability.**
4. **You'll find that Shell Alvania Grease extends time between greasings . . . a substantial saving in labor and grease.**
5. **Simple inventory . . . just the one grease to stock and apply.**

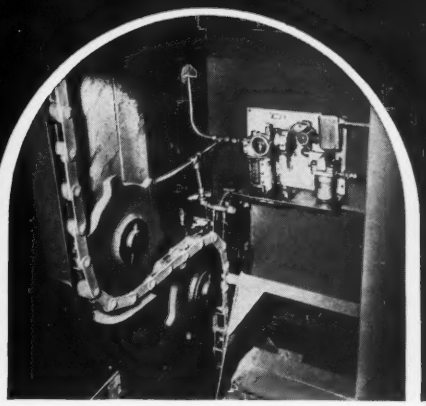
Shell Alvania Grease may well be the answer in your plant. Write for technical information on Shell Alvania Grease, to Industrial Lubricants, Shell Oil Company, 50 West 50th Street, New York 20 New York—or 100 Bush Street, San Francisco 6, California.

SHELL ALVANIA GREASE

The True Multi-Purpose Industrial Grease

SHELL

telling the story of 'dag' dispersions



Dry-Film Lubricants Resist Heat and Chemicals

Where conventional lubricants fail . . . on oven conveyors, bearings of kiln-car wheels, conveying equipment for hot strip steel or for degreasing tanks where most lubricants are destroyed . . . 'dag' Colloidal Graphite provides a durable, heat-proof, *dry lubricating film.* This remarkable film is unaffected by heat up to 750° F., and is fully effective under most conditions at much higher temperatures.

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If your operations impose severe conditions upon the lubricants you are now using, send for helpful details of the remarkable 'dag' dispersions in Bulletins No. 424-F6 and No. 435-F6.

Dispersions of molybdenum disulfide are available in various carriers. We are also equipped to do custom dispersing of solids in a wide variety of vehicles.

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Port Huron, Michigan

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dag DISPERSIONS

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LUBRICATION CO. OF AMERICA, Los Angeles, Calif.
MacMILLAN OIL CO. OF ALLENTOWN, Allentown, Pa.
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MID-STATES LUBRICANTS, Kansas City, Mo.
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RILEY BROS., INC., Burlington, Iowa
SERVICE LUBRICANTS, INC., Chicago, Ill.
SOUTHWEST GREASE & OIL CO., INC., Wichita, Kan.
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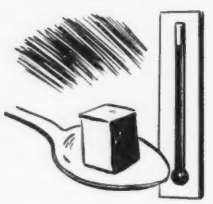
NATIONAL LEAD CO.
BAROID SALES DIVISION
P. O. Box 1675, Houston 1, Texas

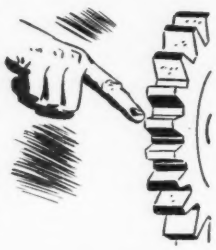
what makes

THE LONG-LIFE LUBRICANT FOR YOUR MULTI-PURPOSE USE . . .

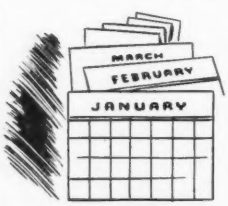
WATER RESISTANCE—The ability of Bentone greases to resist washing action is excellent. Bentone greases will take up water by absorption or emulsification, but will not lose consistency. Bentone greases are not subject to hydrolysis and thus do not break down and separate into two phases in the presence of water.



HEAT STABILITY—The consistency-temperature characteristics of Bentone greases are far superior to those of conventional greases. They will not melt below the decomposition point of the oil.



METAL ADHESION—The adhesion of Bentone greases to moving metallic surfaces is one of their best properties—far superior to all conventional greases. A grease may have many excellent properties, but if it fails to adhere to moving metallic or other surfaces, it is useless.



LONGER SERVICE LIFE—The mechanical and chemical stability of Bentone greases is excellent, with superior resistance to bleeding and separation, with wear characteristics comparable to those of the best grease products.

WRITE FOR FREE BROCHURE—This Bentone* 34 fact book tells you what it is, how it's made, how it gels, and why Bentone greases are superior for all your multi-purpose use. Write for your personal copy today.

Call your nearest Bentone 34 grease distributor today*

FOR COMPLETE INFORMATION ON BETTER LUBRICATION

Bentone* 34 greases *better*

for longer trouble-free service life!

HERE'S WHAT BENTONE* 34 GREASE USERS SAY . . .

"We are finding the Bentone grease very acceptable for lubricating our heavy equipment, using it on chassis, wheel bearings, reciprocating bearings, and the lubricated crawler mechanisms."

"The Bentone grease appears to have outstanding resistance to oxidation, and does not break down under heavy shock loads."

"Its superior water resistance protects the bearings against rusting and corrosion from water which frequently enters the bearings in service."

Bentone 34 multi-purpose lubricants can save you time and money, too, where dust, water, steam, extreme temperatures and extreme pressures are a problem.

Dutch Boy *
TRADEMARKS REGISTERED U. S. PAT. OFF.

BENTONE* 34
THE NON-SOAP GELLING AGENT

NATIONAL LEAD COMPANY
BAROID SALES DIVISION ★ P. O. BOX 1675 ★ HOUSTON 1, TEXAS

a "lubrication fitting" that out-thinks a man...

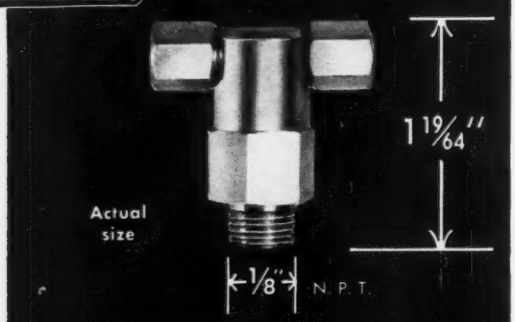
ALEMITE Accumeter®

The low-cost, simple way for you to design fool-proof, automatic lubrication into a machine with many small bearings

Many small bearings on a compact, high-speed machine. You know that proper, exact lubrication is essential, but you also know how crowded the bearings will be. You know that they will be difficult or impossible to reach with grease gun or oil can and that some of them will be missed—and the shutdown time for lubrication will be costly.

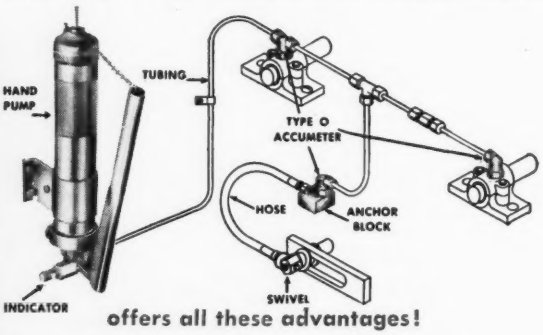
The answer? Alemite Accumeter, the valve that never forgets. This tiny, accurate, and very simple valve automatically meters an *exact* amount of lubricant to the bearing, at exactly the right time, *while the machine is in operation!* Time, maintenance and production costs drop—output soars! That's the reason that better than 95% of all major plants buying machine tools specify centralized lubrication.

Alemite Accumeter Systems are simple and economical to design into any machine—and there is a system perfect for any machine lubrication problem. Find out about these automatic systems now. See for yourself the savings and efficiency they bring to your designs and you too will specify automatic Accumeter.



Type O Accumeter Valves

Meters .005 cubic inch of oil to rotary, oscillating, stationary—plain or anti-friction bearings. Up to 200 small bearings can be served by the single-line system equipped with these fixed output valves. Requires only 3/16" approximate turning radius



offers all these advantages!

- **Eliminates shutdown time for lubrication. Adds productive time to machine output**
- **Seals completely against dirt, grit, water all the way from "Barrel-to-bearing"**
- **Prevents bearing troubles due to neglect or use of wrong lubricant**
- **Services all bearings—including those inaccessible or dangerous—in one operation**
- **Avoids work spoilage and bearing repairs due to over-lubrication**

factory tested—field proved

Exhaustive, in-the-field tests show no appreciable variation in the amount of lubricant discharged after 73,312 lubrication cycles—*equal to* 122 YEARS *of twice-a-day service!*

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A PRODUCT OF SW STEWART WARNER

Free—*Alemite Accumeter Catalogue*

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progress report on PERMAGEL

Introduced in mid-1953, Permagel has already captured the imagination of many leading grease-makers. Reasons: greases made with this versatile thickening agent offer exceptional mechanical and thermal stability, good water resistance and effective corrosion protection. Also, Permagel permits wide flexibility in formulation and helps insure grease reproducibility.

Permagel will help *you* make better greases, too. Ask for Bulletin P-53 and for samples of Permagel for laboratory evaluation. And let us process your base oils in our modern pilot plant.

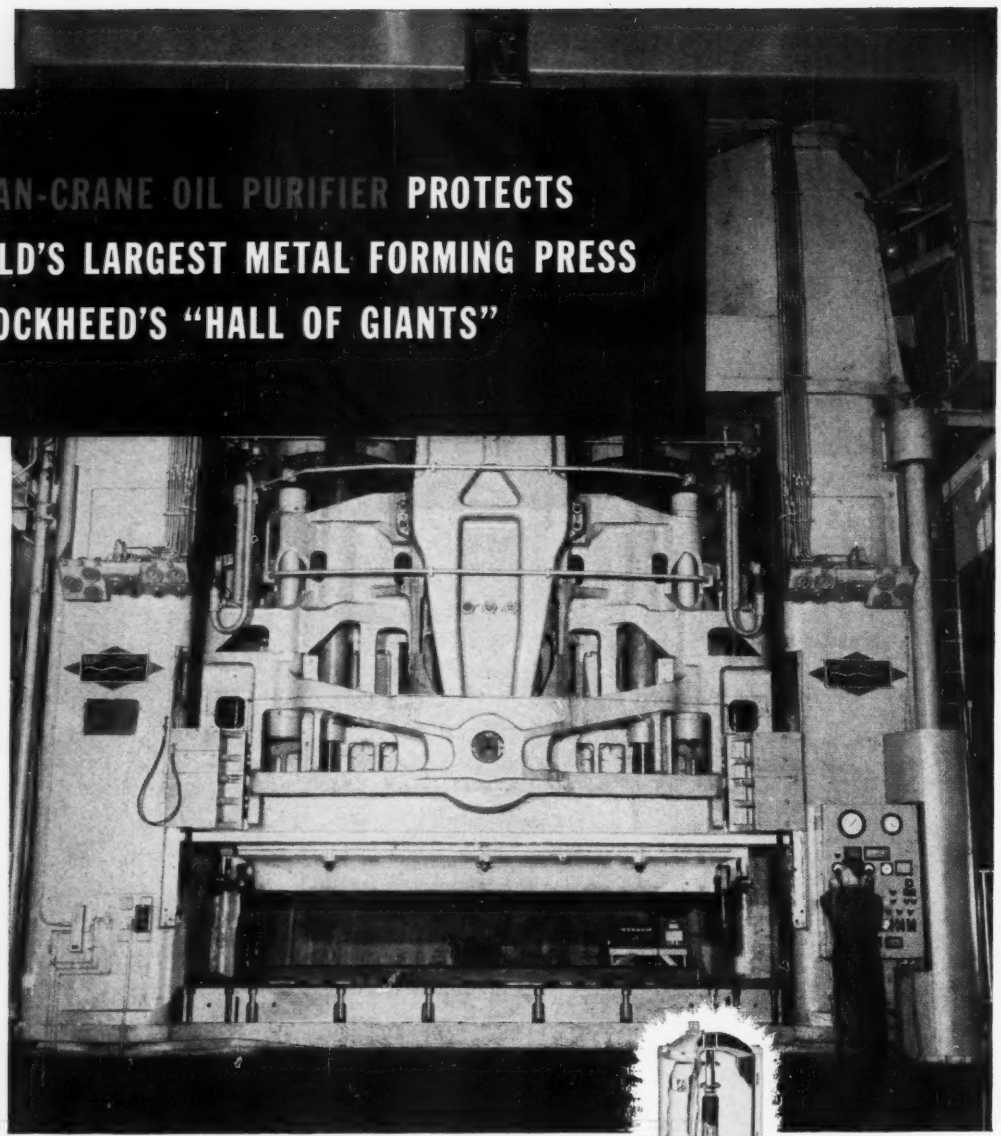
ATTAPULGUS Minerals & Chemicals Corporation

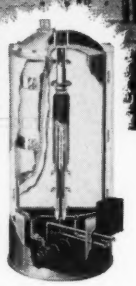
DEPARTMENT K

210 WEST WASHINGTON SQUARE, PHILADELPHIA 5, PA.

PERMAGEL

HONAN-CRANE OIL PURIFIER PROTECTS WORLD'S LARGEST METAL FORMING PRESS IN LOCKHEED'S "HALL OF GIANTS"





Honan-Crane Bulk Refill Purifier No. 21300 with built-in pump and motor services Birdsboro press pictured. Purifier operates 20 feet below floor level. This model is capable of servicing a 2,000-gallon system.

● Aircraft sections up to 10 by 30 feet are formed from ½" aluminum sheets on this Birdsboro hydro press. Its overall height is 51 feet and its weight a staggering 2,750,000 pounds. Because clean hydraulic oil is a vitally important factor in the operation of this mammoth press, Lockheed gives it the safe, dependable protection of a Honan-Crane Oil Purifier.

You'll find Honan-Crane Purifiers in America's finest plants . . . protecting equipment of all kinds and sizes from the wear and damage caused by oil contamination.

Give your plant the benefit of Honan-Crane's 30 years' filtration experience. There's a Honan-Crane Purifier for complete removal of either solid or soluble contaminants from hydraulic, lubricating, insulating and other oils. Sales engineers in principal cities are at your service. Write for engineering bulletins covering your specific problem.

HONAN-CRANE CORP.

818 WABASH AVENUE • LEBANON, INDIANA

a subsidiary of **HOUDAILLE-HERSHEY CORP.**

THESE 3 SUN GREASES WILL DO 95% OF YOUR GREASE LUBRICATION JOBS

—save you the cost and trouble of stocking a large number of "special purpose" greases

FIBROUS • Sun Grease 844X

Has exceptional oxidation stability under high temperature conditions. Recommended for all antifriction bearings. A general-purpose, high melting point lubricant for pressure gun and grease cup application.

BUTTERY • Sun Grease 300A

Especially designed for pressure lubrication of bearings operated at normal speeds and temperatures. Can be used in pressure guns, compression grease cups, or pressure lubrication systems. Has high water resistance and excellent pumpability at low temperatures.

TACKY • Sun Grease 897

For open gears, chains, slides, cams, linkages and bearings. Used whenever "throw-off" must be avoided. High adhesive and cohesive characteristics. An excellent lubricant that is water resistant and does not need frequent application.

Of the 81 different Sun greases, these three can fill the vast majority of your needs. And lubrication simplification like this means worth-while economies for you in several directions. You can reduce the total amount of money you need to "invest" in lubricants. You can greatly lighten the housekeeping job of storing and handling your greases. And you can reduce the confusion and risk of error often created when personnel are required to choose from a large number of greases.

For lubrication points that do require special kinds, Sun offers a total of 78 other greases with a wide range of properties and characteristics.

Find out just how much you can economize by using Sun lubricants. Call in your Sun representative. Or write for information. Dept. LE-6.

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

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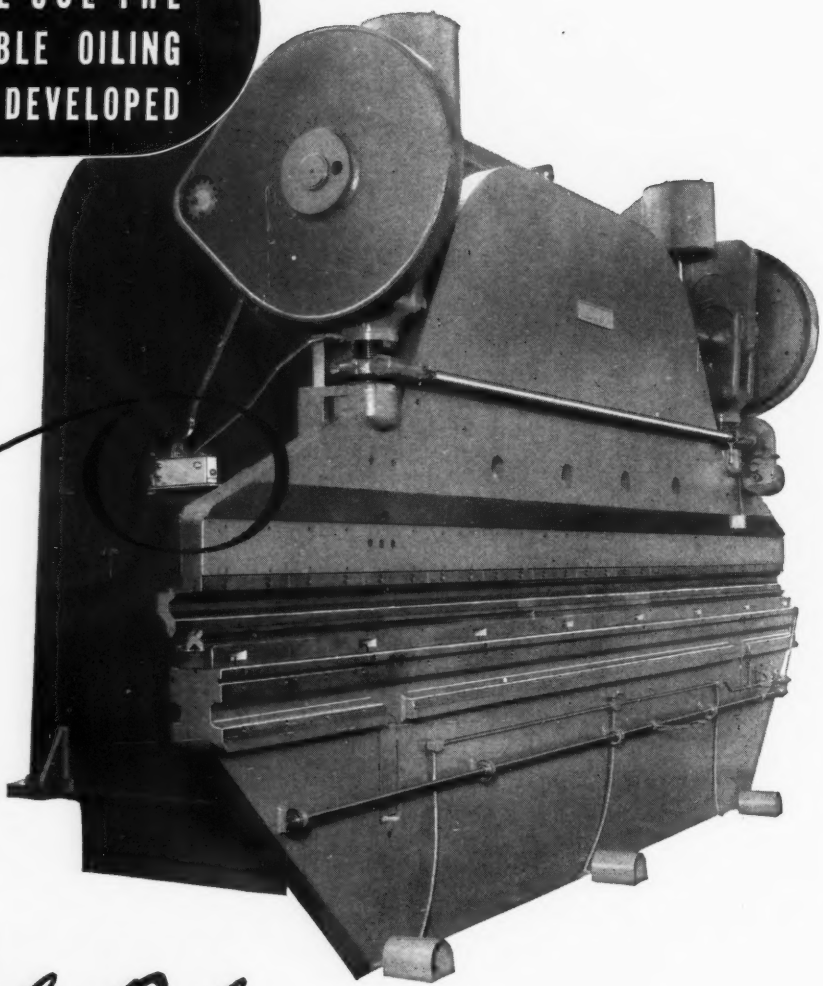
Refiners of famous High-Test Blue Sunoco Gasoline

MACHINES OF GREAT PERFORMANCE USE THE MOST DEPENDABLE OILING SYSTEM EVER DEVELOPED



Illustrated is Madison-Kipp Lubricator Model FD installed as original equipment on a 3/8" by 20' Cincinnati Press Brake, manufactured by the Cincinnati Shaper Co., Cincinnati, Ohio.

MADISON-KIPP

Fresh Oil . . . by the measured drop, from a Madison-Kipp Lubricator is the most dependable method of lubrication ever developed. It is applied as original equipment on America's finest machine tools, work engines and compressors. You will definitely increase your production potential for years to come by specifying Madison-Kipp on all new machines you buy where oil under pressure fed drop by drop can be installed.

MADISON-KIPP CORPORATION

223 Waubesa Street, Madison 10, Wis., U.S.A.

ANCIENS ATELIERS GASQUY, 31 Rue du Marias, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

WM. COULTHARD & CO. Ltd., Carlisle, England, sole agents for England, most European countries, India, Australia, and New Zealand.

- *Skilled in* DIE CASTING *Mechanics*
- *Experienced in* LUBRICATION *Engineering*
- *Originators of Really High Speed* AIR TOOLS

this is Norgren

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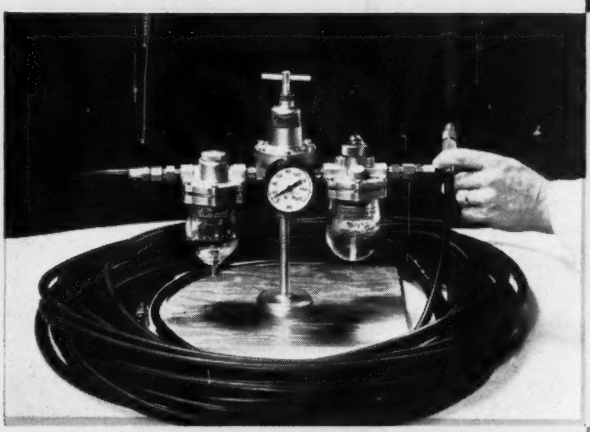
Special test chamber in Norgren research laboratory shows the fine, uniform Micro-Fog.



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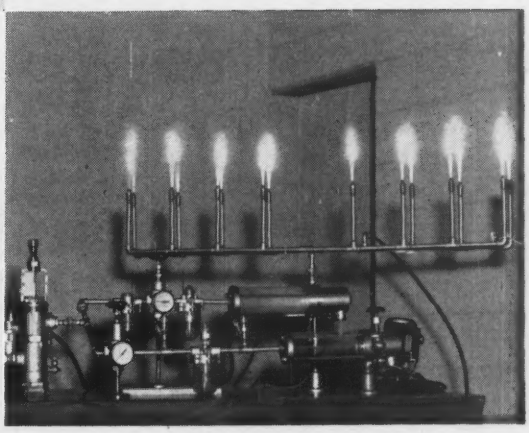

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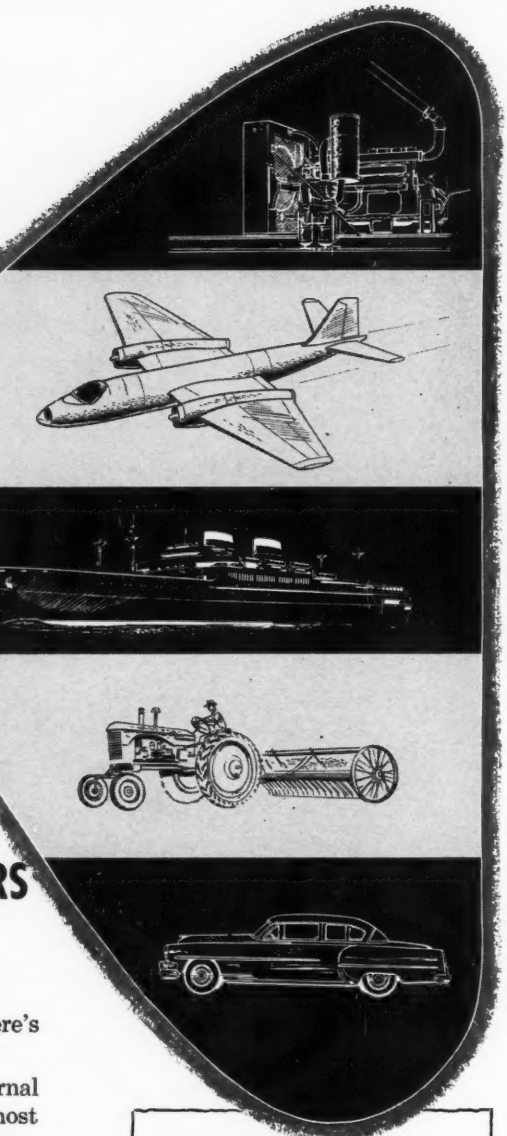

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The Fine Art of Steel Making #1

For 60 years the history of American industry has been the story of steel. You know the landmarks. The old, slow hand mill. Table trains with their lusty offspring, the continuous strip mill. And more recently, the speedy, almost automatic four-high mill.

During these 60 years every forward step in steel production has been paralleled by an equal advance in Ironsides Gear Shield lubricants. Heavy duty Gear Shield, once hand-paddled onto exposed gears, is now formulated with a solvent for quick spray application.

With increased use of encased gears, Gear Shield was produced in liquid form for pouring, pumping or timed-jet application. As pressure on production increased, Ironsides was among the leaders in developing extreme pressure lubricants.

Today, so widespread is the acceptance of Ironsides lubricants that other makers often refer to their own products as "gear shields", even though Gear Shield is an Ironsides trade mark.

Ironsides is not mass production. We are the "custom tailors" of lubrication. Our special position is due in large part to our flexibility. We can—and do—formulate for individual applications and supply these formulas in any quantity from pails to tank cars.

We like tough problems, and we've solved a lot of them. For example, Palmoshield, replacement for palm oil and most important advance in lubrication since World War II.

If you have a special problem, we'd like to help you lick it. A letter or phone call will summon one of our research engineers. Address The Ironsides Company, Columbus 16, Ohio.

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BALTIMORE CONFERENCE on LUBRICATION

ASME & ASLE

plan joint meeting

October 18 & 19, 1954

The ASME Lubrication Activity will hold its first Lubrication Conference in joint session with ASLE at the Lord Baltimore Hotel, Monday and Tuesday, October 18 and 19, 1954. Headquarters for all sessions will be at the Lord Baltimore Hotel, Baltimore, Maryland. Papers will be sponsored by both societies in five sessions dealing with:

(a) Journal bearing behavior and hydrodynamics
(b) Recent research results on friction and wear
(c) Ball bearing friction and lubrication
(d) Analysis of pressure-viscosity effect in oils
(e) Grease lubrication studies

Increased interest in the science of lubrication has created the need for a conference devoted completely to this specific field. This conference will provide an assembly for the presentation and discussion of problems encountered and progress made in the field of lubrication.

Reserve these dates now!

(More complete program soon)

Lube Lines

CONFERENCE ON LUBRICATION. A 'Conference on Lubrication' (sponsored jointly by ASME & ASLE) is to be held October 18 & 19, 1954, at the Lord Baltimore Hotel, Baltimore, Maryland. The Conference will cover a broad range of lubrication subjects and will supersede the Symposium on Synthetic Lubricants which was originally planned for October 18 & 19, 1954, and is being postponed to a later date.

ASLE President-Elect, J. Boyd (right), Westinghouse Electric Corp., is presented the gavel by Retiring President, W. E. Campbell, Brush Laboratories Co., at the ASLE Annual Banquet, Netherland Plaza Hotel, Cincinnati, April 6, 1954.

PRESIDENT'S MESSAGE. With the recent Annual Meeting in Cincinnati, the American Society of Lubrication Engineers rounded out the first decade of its existence by breaking all previous records and entered into its eleventh year with vigor and enthusiasm. While the Society has had a steady growth from the time of its inception, the early years were lean ones and there were times when the going was rough. Time has shown, however, that the founders' vision of creating a society devoted to "advancing the knowledge and application of the science of lubrication" has fulfilled a vital need. The roots of the Society are now firmly established and ASLE stands out, first, as the only organization devoted exclusively to lubrication and second, as the only one providing complete coverage of the field. In fact, the Society has already established the reputation for being **the** agency for the exchange of all types of information on lubrication and is rapidly coming to be regarded as **the** medium for keeping abreast of new developments.

This does not mean that we can now sit back and let matters take their course. There is still far too much to be done and far too little appreciation of the importance of proper lubrication to permit any such point of view. Certainly none of the committees or none of the officers of the Society are taking this position.

In the coming year all of the activities which were carried out last year will be continued. There is no need to discuss the present program in detail but a few new developments may be of interest.

The question of the preparation of a Lubrication Handbook has reached the serious study stage and various aspects of the problem are being actively considered. This is not a project which can be carried out on short notice but it is hoped to make a good start upon it within the coming year.

A glossary of lubrication terms which has been in preparation for some time will be released soon in tentative form.

The Society's journal, **Lubrication Engineering,** which has been undergoing numerous changes aimed at the production of a better magazine will be further improved with the view of making it the unquestioned leader in its field.

Many of the Technical Committees will be broadened and new committees, or new subdivisions dealing with new classifications of activities, will be made.

Some of the Technical Committees will establish groups for recommending, and in some cases for carrying out, research and development on problems of interest to industry.

As previously mentioned the above projects are only a small fraction of the effort which will be made in the current year but they give some idea of the work which will be taking place. It is confidently expected that the coming year will be no exception in the steady growth and development of the Society.

J. Boyd

TREASURER'S REPORT. Excerpts from the report of W. H. Fowler, Jr., (ASLE Sec'y-Treasurer) The Pure Oil Co., presented at the ASLE 9th Annual Business Meeting, Cincinnati, April 5, 1954, include: "The status of the Society, from the standpoint of growth in membership, financial strength, and general activities, has materially improved during the past year.

Membership as of April 1, 1954, was 2,418. This

John Boyd, Manager of the Lubrication Section of the Research Laboratories, Westinghouse Electric Corp., is a native and resident of Pittsburgh, and received his BS and MS degree in Mechanical Engineering from the Carnegie Institute of Technology. After serving four years as an Instructor of Mechanics & Strength of Materials for the Carnegie Institute, he became affiliated with Westinghouse Electric Corp. in 1933 as Research Engineer on high temperature properties of materials; in 1938 as Design Engineer of steam turbines, in 1939 as Research Engineer on Lubrication & Bearing Research, and in 1945 assumed his present duties. He is an active member of ASLE and ASME; in ASLE he has served as a Director, as Vice-President at Large, as Chairman of (1) the Pittsburgh Section, (2) the Technical Committee on Bearings & Bearing Lubrication, and (3) the Pittsburgh Lubrication Conference (jointly sponsored by ASLE and the University of Pittsburgh), and as a member of the Education Committee. He has served as a member of the ASME Research Committee on Lubrication, and ASME Lubrication Activity, and has been a Lecturer in Mechanical Engineering on Lubrication & Bearing Design at the University of Pittsburgh since 1945. Mr. Boyd married the former Wondov Nielsen of Trafford, Pennsylvania; they have a daughter, Joanne, who is a Senior at Carnegie Tech.

compares with 2,194 a year ago.

Our financial strength has grown to the point where we now have almost $20,000 in the reserve account. It is expected this account will reach $30,000 within the next year. Our aim is to build the reserve account to a level equal to our operating expense for one year to provide necessary insurance against difficult times. Once this goal is attained, it will be possible to divert a greater share of our income to educational programs and other activities beneficial to our members.

Figs. 1 & 2 graphically illustrate the sources from which we derive our income and where our disbursements are made. (Note that membership dues account for but 42.6% of our total income.) The small segment not identified in Fig. 1 represents income from investments. The small unidentified segment in Fig. 2 covers miscellaneous dues, donations, legal and auditing expense.

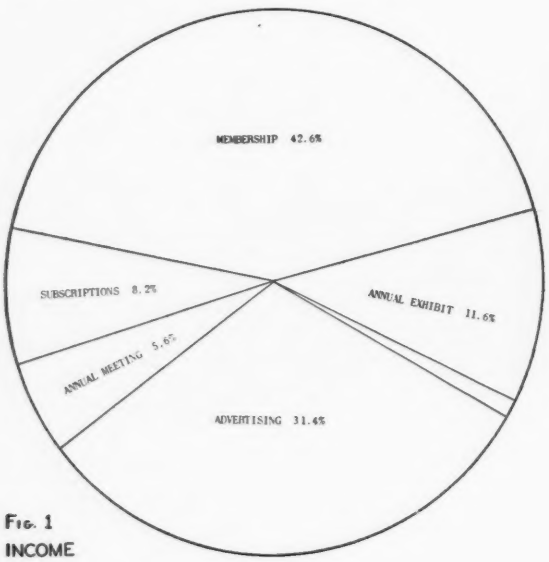


Fig. 1
INCOME

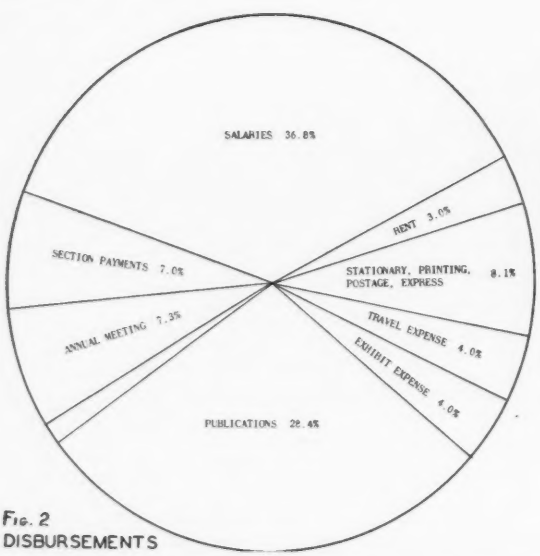


Fig. 2
DISBURSEMENTS

Various committees are actively engaged in furthering programs involving editorial content of **Lubrication Engineering** and other publications, education, standards, finance, etc. Each year finds the Society stronger, more active and more important in the field of lubrication, and all of us can feel proud in being identified with it."

I.I.T. TO OFFER REFRESHER COURSE. The Illinois Institute of Technology has announced a two-week refresher course in "Basic Oil Hydraulics" to be held June 7 thru June 18. Initiated at the request of numerous industries using oil hydraulics, the course is designed for maintenance technicians and others already working in the hydraulic field. A non-credit course, further information may be obtained from the Dept. of Mechanics, Illinois Institute of Technology, 3300 S. Federal St., Chicago 16, Ill.

ANNUAL MEETING HI-LITES, ASLE 9th Annaul Meeting & Exhibit, Netherland Plaza Hotel, Cincinnati, Ohio, April 5-6-7, 1954:

(Left) The Alfred E. Hunt Memorial Medal, sponsored by the Aluminum Company of America, was awarded to E. E. Bisson (right), National Advisory Committee for Aeronautics, for the best paper on the subject of lubrication in 1953.

(Right) The ASLE National Award, signifying life membership in the Society for an individual making outstanding contributions to the furtherance of the science and practice of lubrication, was awarded to A. F. Brewer (right), The Texas Co.

(Left) The Walter D. Hodson Award, awarded annually for the best paper on lubrication or an allied subject by a member 30 years of age or less, was presented to I-Ming Feng, Massachusetts Institute of Technology. Dr. B. G. Rightmire (left) of M.I.T. accepted the award in the absence of Mr. Feng.

(Right) Retiring President, W. E. Campbell (right), Brush Laboratories Co., is presented a testimonial plaque of appreciation by the Chairman of the Presidential Council, M. E. Merchant, The Cincinnati Milling Machine Co.

A partial view of the exhibits at the ASLE 9th Annual Meeting & Exhibit, Netherland Plaza Hotel, Cincinnati, April 5-6-7, 1954.

(Inset) Toastmaster E. M. Glass (right), Hq. Air Material Command, AAF, congratulates Dr. Morgan Sparks, Bell Telephone Laboratories, guest speaker for the ASLE Annual Banquet. Mr. Sparks' subject was "The Transistor, Mighty Electronic Midget."

Mrs. M. E. Merchant (end right, second row), Chairman of the Ladies Program Committee, is pictured with the ladies present at the ASLE 9th Annual Meeting & Exhibit.

M.I.T. TO OFFER SPECIAL SUMMER PROGRAM. The Massachusetts Institute of Technology has announced three special summer programs to be held concurrently June 15 thru June 25: (1) Internal Combustion Engines, emphasizing the analytical approach to performance, development, and design problems, under the direction of C. F. Taylor, Professor of Automotive Engineering and Director of the Institute's Sloan Laboratories for Aircraft & Automotive Engines; (2) Lubrication Engineering, to give engineers in industry an opportunity to study the applications of new techniques and methods, under the direction of Dr. B. G. Rightmire, Associate Professor of Mechanical Engineering, who is in charge of the Lubrication Laboratory; and (3) Developments in Machine Tool Technology, emphasizing topics associated with all phases of the use of machine tools, under the direction of Dr. M. C. Shaw, Professor of Mechanical Engineering, who is in charge of the Machine Tool & Metal Cutting Division in the Mechanical Engineering Department. Further information and application blanks may be obtained from the Summer Session Office, Room 7-103, M.I.T., Cambridge 39, Mass.

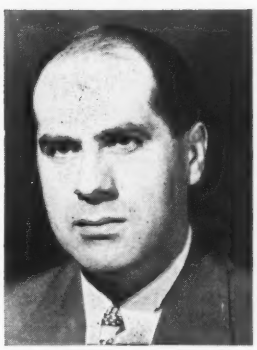
Meet the Authors

J. M. Bailey (p. 155)

R. S. Barnes (p. 147)

T. H. Cafcas (p. 147)

D. W. Criddle (p. 143)



D. Godfrey (p. 155)

A. C. McKeen (p. 140)

W. J. Polny (p. 151)

R. G. Sturm (p. 151)

PLANNED LUBRICATION SAVES CADILLAC MONEY

by A. C. McKeen*

Cadillac has included planned lubrication as a part of its preventive maintenance programme and reports that it pays dividends. Reductions in maintenance and downtime were obtained as well as in lubricant inventory and consumption.

ATTENTION STEP

I. Modern factories have millions of dollars invested in mechanical equipment.

II. Many modern factories are not protecting the investment in machinery by having an effective lubrication program as an integral part of their preventive maintenance program.

NEED STEP

I. Increased mechanization has brought about a need for greater interest in lubrication methods.

II. Lack of a planned program of lubrication can result in hit or miss methods that cause both excessive downtime and excessive part replacement.

SATISFACTION STEP

I. A planned lubrication program must be composed of a few essential steps.

(a) Each machine in a department must be studied to see what parts must be lubricated.

(b) Manufacturer's recommendations and past experience should be used to determine a frequency at which each point should be lubricated.

(c) Each item to be covered should be scheduled in book form so that the oiler can follow a route and grease or oil each part as required.

(d) The services of a qualified lubrication engineer should be used to determine the correct lubricant to be used in each instance.

II. The results of a planned lubrication program are very gratifying.

(a) Hit and miss lubrication is eliminated.

(b) The different types of oils and grease stocked can be reduced.

(c) Money can be saved by elimination of downtime and excess wear on equipment.

(d) Money can be saved on the amount spent for lubricants.

ACTION STEP

I. The planned lubrication program has resulted in a better job at less cost.

II. Any plant not having a planned lubrication program that is willing to expend the effort can have similar results.

It is not unusual for modern factories to have millions of dollars invested in mechanical equipment. Each new piece of equipment in a plant is carefully selected to give the maximum amount of quality production at minimum cost. Even though considerable thought is always given to investment in new equipment some plants give very little thought to protecting that capital investment by having an effective and planned lubrication program as an integral part of their preventive maintenance program. In recent years much effort has been expended by industry to produce a higher quality product at less cost to the buyer. In this two-fold objective one possible avenue of savings is often overlooked. That method is in studying plant lubrication to save excessive wear and cut the cost of lubrication through better methods.

Increased mechanization has crept up on some factories so slowly that they have not realized what a complex lubrication problem has developed. It was often left to the imagination of the oiler to guess what type of lubricant to use, at what frequency it should be lubricated, and where all the lubrication points were located. The lack of a planned lubrication program can often result in hit or miss methods that can cause excessive downtime, excessive part replacement and even in some cases affect the quality of the product produced.

The basic concept of Cadillac's Preventive Maintenance Program was to establish a route for various journeymen such as millwrights, electricians, oilers and pipefitters in which they would inspect the various machines or conveyors in a department. Their route was determined after studying during what shift and at what interval the inspections should be made. When that was determined a route book was made up for a selected journeyman and he was instructed to perform the work indicated in the book. It was established as a part of his job that he would perform all minor repairs that were uncovered and would turn in a copy of each major defect discovered to his supervisor. This job ticket was then scheduled to be done during a period when the equipment was idle. This allowed the work to be done without hindering production and at a lower cost through efficient use of the repairman's time.

We have made lubrication an important phase of this program. It is of interest to examine this phase in more detail and to illustrate the benefits derived from it.

The first step was to study each machine in the department to see what parts should be lubricated. Each machine and its major points of lubrication were listed. The manufacturer's recommendations were then checked to see at what frequency they advised lubrication. This date was tempered by local conditions and by past experience and a lubrication frequency was established. Each item to be lubricated was then scheduled in book form so that the

*Cadillac Motor Car Div., General Motors Corp., Detroit 32, Mich.

This paper was presented at the ASLE 9th Annual Meeting, Cincinnati, April 6, 1954.

oiler could follow an efficient route and grease or oil each part as required. A study was made on each operation in order to determine a proper work load for each day. It was discovered that an analysis of each operation often disclosed that some operations could be made shorter and easier by simply applying the rules of better methods. In one instance it was possible to reduce the time required to lubricate the wheels on a core oven conveyor by 30%, simply by starting the job in a different location. It was found in some cases that the use of new equipment could pay for itself in a surprisingly short time.

In some cases it was very advisable to consult a qualified lubrication engineer to determine the correct lubricants to be used. Many large concerns are often fortunate in having such engineers on their staff or a lubrication committee to determine the proper lubricants. Even so, large companies, as well as small companies, can often benefit by the experience of lubrication engineers from the various lubricant suppliers who are ready and willing to assist on any problems that arise.

When the proper lubricant was determined, each fitting or group of similar fittings on a machine was tagged so that there was no question as to what lubricant should be used. If this had not been done there was a possibility of the incorrect lubricant being used. Cadillac has developed a lubrication tag of its own design which is color coded for general type of lubricant such as lubrication oil, cutting oil, grease, hydraulic oil and special purpose lubricants. The tags also have the name of the lubricant embossed on them. These tags have practically eliminated any instances where the improper type of lubricant has been used.

One of the most important factors in having a good lubrication program is the careful selection of the oiler. It is very important to have only the most conscientious workers on this job for the oiler has probably the most vital job in the factory. Even if the correct lubricant and frequency have been established it does not do a bit of good unless the lubricant actually reaches the point where it is required. Increasing recognition of the vital task of the oiler will no doubt bring with it an increasing wage scale and with it greater ease in obtaining the best possible men for the job. One personnel procedure which is sometimes overlooked is that of conducting periodic meetings with the oilers. During these meetings it is possible to explain new types of lubricants that are being used and the correct amount of lubricants to be applied to various types of bearings.

The results of a planned lubrication program can be very gratifying. The first and foremost benefit is the elimination of hit and miss lubrication. An old story that illustrates the effect of hit and miss lubrication is that of a Plant Engineer who discovered that his maintenance bill for the year on blowers and blower motors was extremely high compared with the previous year. He happened to mention this to the oiler who said that it certainly was not his fault. He said that he had been greasing all of the blower motors once a month, but they had started to run a little warm so he decided to grease them twice a week. They still ran warm so he started to grease them every day. He knew that it could not be his fault for even though he was very busy lately, he was managing to grease them twice a day.

The setting of a correct frequency, the proper lubricant, and giving the oiler a route book has eliminated hit and miss lubrication. It is a very simple way in which to protect your investment in equipment.

It is very often possible in a plant to reduce the number of required lubricants considerably by making a lubrication survey. Such a survey was completed a year ago in the Cadillac Foundry and resulted in only a total of 12 oils and grease stocked, including several special purpose lubricants used in very small quantities. It would be possible to reduce this amount still further by using higher priced oils on applications where low cost oils are now used satisfactorily. However this would increase the cost of lubrication.

Although it is often difficult to determine the actual cost of machine downtime which can be saved through preventive maintenance and planned lubrication a few illustrative examples can be cited at Cadillac. In the Cadillac Foundry downtime was reduced by 34% in a 6 months period. Every lost minute due to maintenance trouble is logged by the production departments and is multiplied by the number of people affected. Even counting each lost fraction of a man hour lost, the downtime averages less than 7/10 of 1% of the standard production labor hours.

The Cadillac Final Assembly Line is a very complex system. If one of the final assembly conveyors or even one of the feeder conveyors were to break down several hundred production workers would be immediately idled. This is true because of the broadcast method of assembly which Cadillac has developed to a high degree of efficiency in order to "custom build" each automobile to the customer's order. There is to all intents and purposes no bank or float of any major item on the assembly line. Each item is delivered by conveyor to the assembly conveyor at the exact moment this part is needed. This is indeed a problem for the Maintenance Division but it is a challenge which was overcome through Preventive Maintenance. In fact only one and a half years after the program was initiated the total downtime for an entire six month period averaged less than 6 minutes total per month. There was even a period of three consecutive months of peak production in which there was not a second of maintenance downtime. This is a record of which Cadillac is very proud.

One example of a specific instance where lubrication cut maintenance cost, occurred in the case of a large set of open gears on a large flight type of conveyor which carried hot castings. Due to the fact that a casting shakeout in a foundry was operating almost directly below these open gears, it was found that the maintenance costs were high. It was even considered to make a large expenditure in order to totally enclose the gears. However, before this step was taken a special open gear lubricant was used on the gears and the results were amazing. The life of the gear set was increased 4 times.

Automatic lubrication also offers other opportunities for large savings. An automatic lubrication system was installed in the foundry a few months ago on molding machines. One experience with this system shows that the savings in oil alone during this year will exceed $15,000. Not only is there a large oil savings but cost data that is now being compiled shows that the maintenance costs on the

molding machines has been cut drastically. This automatic system is giving better lubrication at much less cost.

The foregoing constitutes only a brief description of the methods by which Cadillac has set up a preventive maintenance program and made planned lubrication an important part of that program. There are many more examples in which better plant lubrication has helped to cut production costs at Cadillac. While it is felt that we have made a good start along the road to good lubrication, there is still a great deal of work to be done. Any plant which does not honestly have a planned lubrication program can benefit greatly by initiating one. The field of planned lubrication and preventive maintenance is a very fertile pasture for the American goal of producing more goods at greater quality at less cost.

COMMENTARY by R. W. Clark, E. I. du Pont de Nemours & Co., Inc. The importance of planned lubrication cannot be overemphasized because it is estimated that the annual cost of lubricants and their application in American industry is about five billion dollars. In our Company, for example, the total cost of lubrication exceeds three million dollars per year. Planned lubrication is a must in controlling expenditures of this magnitude. In one of our plants, which contains about 3,000 pieces of chemical process equipment, lubrication costs were reduced 20 per cent by scheduling and improved lubrication methods.

The discussion of oiler or, as we say, lubrication mechanic selection and training was very interesting. This is an extremely important phase of a successful plant lubrication program and is a subject worthy of much more consideration by plant management than it probably receives. On many of our plants this selection and training program is a continuing one. The reason is that the lubrication mechanics often are transferred to mill-wright and maintenance mechanic assignments so that there is a constant lubrication mechanic replacement problem.

I enjoyed Mr. McKeen's description of the man who greased the blower motor bearings twice a day. A few years ago we had a similar experience with a blower on a 200 F., gas duct. The outboard bearing over three feet away from the duct, was running hotter than the inboard bearing which was almost touching the duct. It developed that the mechanic couldn't get at the inboard bearing but he was keeping the accessible bearing housing crammed full of grease.

I can corroborate Mr. McKeen's figure of twelve oils and greases as being all that are necessary on a plant with a planned lubrication program. Also, I think I can safely say that a plant without a planned lubrication program will probably have from 35 to 45 oils and greases in stock. We know of a plant where the number of lubricants was reduced from 80 to 12 by planned lubrication. The savings in reduced inventory are obvious.

The cost reductions which Mr. McKeen said resulted from their preventive maintenance and planned lubrication program are very impressive. The 34% reduction in machine downtime in a six months' period certainly more than justified the cost of establishing the program.

Planned lubrication can be promoted by lubrication engineers both in consuming industries and the oil companies if they show American management how good lubrication engineering can reduce their production costs. Mr. McKeen has pointed this out in his paper and I sincerely hope that every plant manager whose plant is not using a planned lubrication program will read it.

Lubrication in the News

'Hydra-Lube Pumps.' Trabon has recently published a 4-page illustrated bulletin on their line of Hydra-Lube pumps and reservoir assemblies. Designed for automatic lubrication of hydraulically powered equipment such as machine tools, presses and mining machines, Hydra-Lube pumps connect to the supply line of any double acting cylinder; no control valves are required because twin-sealing with vent between prevents the mixing of lubricant and hydraulic fluid. Three, five and twelve pound reservoir assemblies for grease or oil are available for use with the Hydra-Lube pump; dimensions for both the pump and reservoir are included in the bulletin, as well as a diagram drawing of the method of connecting the pump to any hydraulic circuit. Write for Bulletin A-1-54: Trabon Engineering Corp. (LE10/3), 1814 E. 40th St., Cleveland 3, Ohio.

Multiple Stirrer. A new type of multiple stirrer, featuring 6 spindles and constant temperature bath, has been announced that can be used for all types of multiple laboratory stirring where solutions must be stirred at constant speed and temperature. Bath is thermostatically controlled with hydraulic thermostat; stainless steel stirrers operate at 1000 rpm using dual grease sealed ball bearings. Beakers are 400 cc, tall form type; motor is ball bearing constant speed induction type and drives spindles with an endless Neoprene covered Nylon belt. Made in three and six unit models, modification of standard models can be made to suit individual needs. Write for Bulletin 4140: Labline, Inc. (LE10/3), 217 N. Desplaines, Chicago, Ill.

'Lubricated Valves,' a catalog of lubrication equipment especially designed for the servicing of lubricated valves, has just been released declared to be the most comprehensive and instructive ever published by any manufacturer of lubrication equipment. Various types of lubrication fittings which are inserted in the same threads in place of existing lubricant screws on lubricated valves, special extra heavy duty lubrication guns (both lever and bucket types), hose assemblies, follower plates, pressure gauges and other accessories are covered and their use explained. For copies, write: Alemite Div., Stewart-Warner Corp. (LE10/3), 1828 W. Diversey Blvd., Chicago 14, Ill.

Spray-Lube System. A new spray system, designed to permit more efficient utilization of cutting oils and drawing compounds, has been developed making it possible to increase cutting feeds and speeds and at the same time prolong tool life. Extremely flexible in that the spray can be applied to the work area from any required direction and to as many points as necessary, and presenting a greater exposed surface area of the oil particles which in turn permits more rapid withdrawal of heat from the work area, the net result is reduced tool temperature and improved tool life. For further information, write: C. A. Norgren Co. (LE10/3), 3434 S. Elati St., Englewood, Colo.

'Case for Re-Refined Oil.' A completely revised and enlarged edition of 'The Case for Re-Refined Oil' has just been published. Presenting both the technological and economic aspects of petroleum re-refining as they relate to the oil's use by large industries, transportation companies, and the like, it points out how a number of large industries, including the Glenn L. Martin Co., Pennsylvania Electric Co., Kaiser Co., Pan American Airways, American Airlines, 57 leading railroads, etc., use re-refined oil to cut costs and prolong engine life. An important section is devoted to the increased need for conservation of petroleum and gives figures showing how much motor oil is wasted every year through single use. To those who seek to enter the re-refining business is a chapter devoted to 'Re-Refining As An Investment Opportunity,' giving cost breakdowns on establishment of an efficient re-refining operation, as well as the history of past successes and failures. Other new material included is a section on motor oil additives and their use in today's high compression engines. Documented with maps, charts and technical papers relating to the subject, the publication is available at low cost from: Association of Petroleum Re-Refiners (LE10/3), 1917 Eye St., N.W., Washington 6, D. C.

'No Margin for Error,' a new soundslide film (in full color) containing answers to lubrication problems that are real headaches to cost conscious production men has been released taking the audience into a typical industrial plant showing the right and wrong way to handle lubricants from 'barrel to bearing.' On 35 mm film and lasting 15 minutes, the film presents five plans on lubricant handling ranging from the simplest hand guns and loader pumps, through bucket pumps and transfer pumps, through portable guns and

(Continued on page 165)

SURFACE ACTIVE RUST PREVENTIVES IN LUBRICATING OIL

by D. W. Criddle*

The surface active properties of rust-preventive additives are discussed in terms of their ability to make oil spread on water. Principles are illustrated with simple laboratory demonstrations. Explanations are given for spreading tendency, additive depletion and other phenomena displayed by anti-rust compositions.

A compounded, rust preventive oil protects a steel surface by forming an adsorbed film of additive reinforced by a physical barrier of oil. Literature is available[1, 2] indicating the importance in the performance of a rust preventive oil of the following: (1) the bulk physical properties of the oil; (2) the metal specimen and its surface preparation; (3) application variables such as dipping and draining time (4) changes in the corrosive environment, such as relative humidity and acid vapors; (5) the physical structure and absorption properties of the rust preventive chemical additives.

The surface active nature of rust preventives in lubricating oils has been recognized and discussed by Zisman [2, 3, 4], by Walters and Larsen[1], and by Pitz and Farley[5]. Pitz and Farley were the first to emphasize that rust preventive capacity is related to the contact angle of a water droplet on an oiled steel specimen. Low contact angles were reported to characterize good rust preventive oils. It is the purpose of this paper to emphasize the significance of the surface active properties of rust preventive additives because the ability to spread on water is a necessary, but not sufficient, property for rust preventive oils. Rusting of oil-coated steel involves water which adsorbs, condenses, or falls on the surface; therefore, a study of spreading of compounded oils over water was undertaken to elucidate the role of rust preventive additives.

Spreading of Oil Over Water Depends Upon the Additive. It has long been recognized that oxidation products or polar constituents cause hydrocarbon oils to spread on water. This principle has been utilized to spread oil films over mosquito-infested swamps and to calm the breakers of rough seas. Zisman[4] and Harkins[6] have made detailed studes of the mode of action of surface active chemicals in the spreading of hydrocarbon liquids. However it has not been generally recognized that the ability to spread over water is always found in rust preventive oils. It is herein noted that effective rust preventive oils are sufficiently surface active toward water to make them spread; at the same time these rust preventives must also produce impervious films at each oil-steel interface where oil-film depletion otherwise occurs due to the spreading of the oil over water which may condense or fall on the oil (Fig. 1).

Observations of water droplets on steel panels coated with different compounded oils show that oil can be made to spread over the water droplet as shown in Fig. 1. Note that the protective barrier of oil is depleted as the water displaces the oil and oil spreads over the water drop. However, a residual film of additive reinforced by oil protects against rust when an effective rust preventive additive is present. Fig. 2 shows the effects of surface active additives on the spreading of water over oil. Fig. 2a illustrates the fact that water penetrates and displaces a film of medicinal white oil on a steel surface. Here, the water drop does not flatten and spread over the oil film; similarly, this oil does not spread over water. In contrast, Fig. 2b shows how a mildly surface active additive causes the water to spread somewhat on an oiled panel; simultaneously, an oil film can be observed to spread and to encompass the water droplet. Fig. 2c illustrates the final state when a highly surface active additive is incorporated into an oil. Within the author's experience, heavy duty rust preventive oils spread over water as illustrated in Figs. 2b & 2c.

In line with a recognition of the surface active nature of rust preventive additives, five surface chemistry experiments involving oils are described

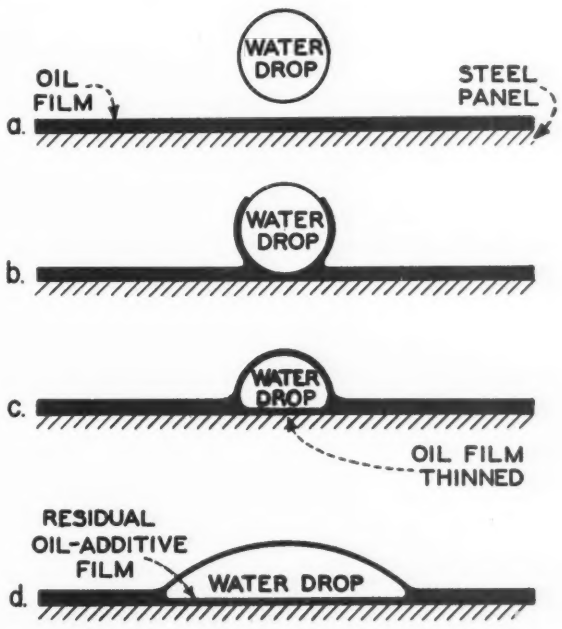


Fig. 1 Water drop falling on an oil-coated steel panel; rust preventive oil spreads over and is partially displaced by a water drop.

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This paper was sponsored by the ASLE Technical Committee on Lubrication Fundamentals, and presented at the ASLE 9th Annual Meeting, Cincinnati, April 6, 1954.

below to help explain the above spreading phenomena.

Spreading of oil over water depends upon the fact that surface active additives concentrate at oil-water interfaces. They also concentrate at oil-metal interfaces, where they help to form protective barriers against corrosion. The ability of a surfactant to concentrate at an interface can be demonstrated readily with a small quantity of the dye, Rhodamine B, placed in a glass vessel containing approximately equal volumes of water, toluene, and air. At rest, no color is detected. If the glass vessel is shaken, an emulsion forms; Rhodamine B concentrates at the interfaces of the emulsion, and the whole emulsion appears pink due to the concentration of dye at the interfaces of the emulsion droplets. As shaking stops, the emulsion breaks and the system appears colorless because the surfactant is no longer suffiiciently concentrated in any region to show color.

A highly surface active additive causes an oil first to spread on water and subsequently to coalesce into droplets. Of the oils which spread over water in a container, those with mildly surface active additives remain spread; whereas, others with more potent surfactant additives coalesce into droplets of oil, each leaving a film of surfactant on the water (Fig. 3). An example of this is provided by an oil containing 3% of commercial sorbitan monooleate (Span 80 of Atlas Powder Company). If a drop of this oil is carefully added to a water surface in a Petri dish, the oil "flash spreads" at about 10 cm per second, covering the water surface with an oil film. Gradually, the surface active material concentrates at the water surface and exerts a film pressure[6] such that the oil film coalesces into droplets. As the surface active additive concentrates at the interface, the cohesive forces of the oil exceed the forces of adhesion of the oil to the water surface; consequently, oil droplets form and the water is left covered with an invisible, monomolecular film of additive.

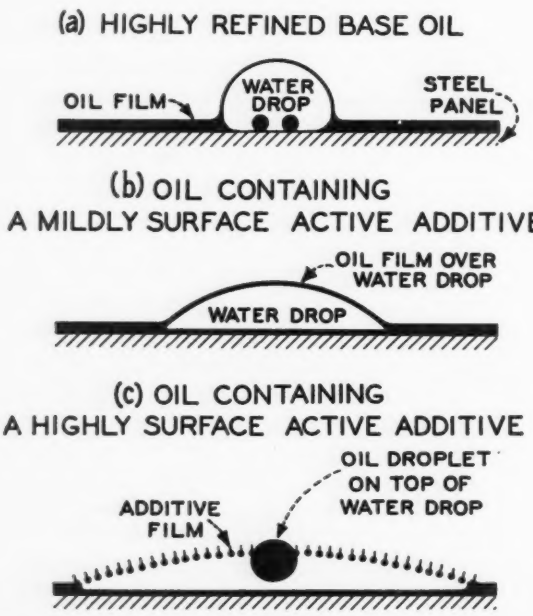
(a) HIGHLY REFINED BASE OIL
OIL FILM
WATER DROP
STEEL PANEL
(b) OIL CONTAINING A MILDLY SURFACE ACTIVE ADDITIVE
OIL FILM OVER WATER DROP
WATER DROP
(c) OIL CONTAINING A HIGHLY SURFACE ACTIVE ADDITIVE
OIL DROPLET ON TOP OF WATER DROP
ADDITIVE FILM

Fig. 2 Effect of oil-soluble surfactants on the spreading over water of oil from an oil coated panel.

Another way of illustrating the above phenomenon is to add one chemical to the oil to make it spread and to use a second, more surface active chemical to make the oil coalesce. If a thin oil film is formed on water by adding a drop of oxidized oil to a water surface and the tip of a spatula containing some highly surface active chemical is touched to the surface, the surfactant spreads on the water exerting a film pressure greater than that of the oil film and causing the oil film to recede and eventually to coalesce into droplets as shown in Fig. 3.

Rust preventive oils should be stable when stored. Surfactants dispersible in an oil as aggregates rather than as micellar or molecular units separate upon storing. These aggregates can readily be detected in oils by spreading experiments[2]. Although a freshly prepared solution of oil containing 2% commercial dioctyl sodium sulfosuccinate (Aerosol OT) is clear to the eye, the presence of surface active aggregates can be detected by adding a drop of this oil to a water surface. The oil first spreads rapidly over the water surface; then, as the surface active aggregates reach the oil-water interface, they spread and rupture the oil film (Fig. 4). This phenomenon can be observed in "slow motion" by first adding a drop of Span 80 to the water surface. Part of the Span 80 spreads as a monomolecular film, the remainder forming a lens on the water surface. Next, a drop of oil containing 2% Aerosol OT is added to the film-covered water but does not spread. If the surface film pressure is reduced by sucking the Span 80 droplet and some of the surface film into a vacuum line, the oil droplet spreads as the film pressure is reduced. The spreading of the oil results in surface active aggregates of Aerosol OT reaching the oil-water interface where they spread rapidly and rupture the oil film. However, the Aerosol OT, being water soluble, dissolves in the water and the oil film can be seen to repair itself. With water in-

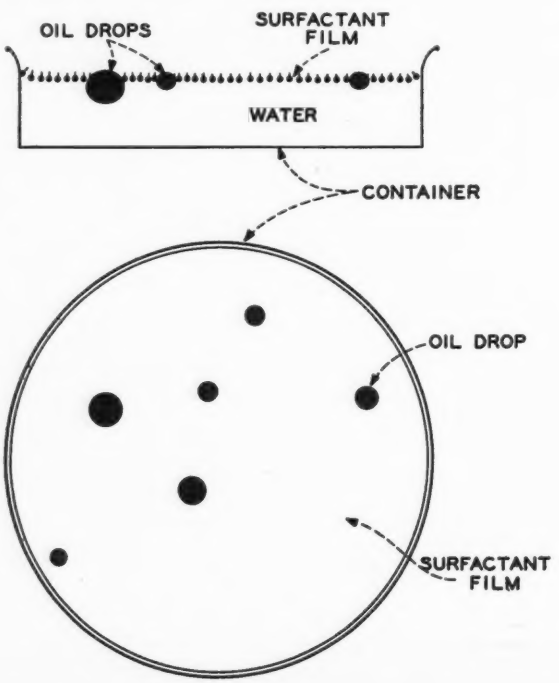

Fig. 3 Coalescence of an oil film by surfactants.

soluble additives, the aggregates form permanent monomolecular islands in the oil film. Effective rust preventives, within the experience of the author, do not exist as aggregates in oil solution as shown by the above test.

Surface chemists have defined and measured the properties of gaseous, liquid, and solid phase surface films on water[6]. The reality of the differences between these film phases and the effect they have on the spreading of oil on water can be shown as follows, taking oil "A", an oxidized mineral oil, and oil "B", a mineral oil containing 3% polyoxyethylene sorbitol tetrastearate (G 1050 of Atlas Powder Company). A drop of oil "A" added to a water surface is seen to spread and to have a uniform oil film on the water. A drop of oil "B" added to the center of this film ruptures and partially displaces the film of oil "A" (Fig. 5). Soon the additive in oil "B" orients at the oil-water interface to form a rigid film. The reality of the differences in these solid and liquid surface films can be shown by moving a spatula tip through the films. Oil "A" is displaced in typical liquid fashion; the rigid oil "B" film is moved as a unit. In the author's experience, surfactant additives forming solid phase surface films on water have not been effective, heavy duty rust preventive compounds.

Relation of the Spreading Properties of an Oil Over Water to Rust Preventive Effectiveness. The rusting process for oil-coated steel involves water which condenses or falls on the oil-vapor interface and which subsequently penetrates the protective film. Condensing moisture, intermittent raindrops, or stationary, adhering droplets of water all provide opportunities for rust preventive oils to spread over water. With continuous condensation of moisture onto a steel surface coated with a rust preventive oil, the combined effects of film depletion due to the spreading of oil over this water and the leaching of the additive by the water accelerate the penetration of the protective film.

In view of the diverse spreading properties of oils illustrated above, it is now more clearly understood that the spreading phenomena shown in Fig. 2b & 2c are possible with the proper rust preventive surfactants. Fig. 2a illustrates the fact that water displaces a highly refined mineral oil on a metal surface; in this case, rusting occurs rapidly. The spreading phenomena illustrated in Figs. 2b & 2c were described in detail above. The oriented film of surfactant shown in Fig. 2c exerts a high film pressure on water capable of maintaining the oil as a coalesced droplet. The oil droplet in Fig. 2c seeks the top of the water drop.

The depletion of the protective oil film due to the spreading of oil over water droplets is in harmony with the observation that rust is often observed first at the outer edges of water drops on oiled steel surfaces (Fig. 6) while corrosion or pits occur near the centers of the water droplets. On the basis of the electrochemical theory of rusting, steel near the center of a water drop is electrochemically oxidized to ferrous ions. These ions diffuse toward the water-air interface where further oxidation occurs due to oxygen from the air, and the rust products are precipitated. If the water drop evaporates, the rust products are concentrated at the periphery of the original water drop, giving the familiar ring pattern of rust products. This electrochemical activity is undoubtedly accelerated by the above described depletion of oil at the metal-oil interface under the drops.

Although the exact correlation is not clear be-

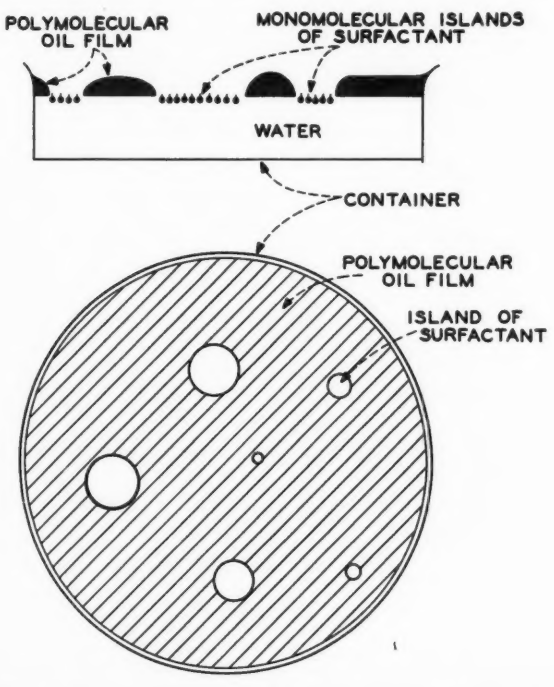

Fig. 4 Pattern caused by surface active aggregates at the interface of an oil film on water.

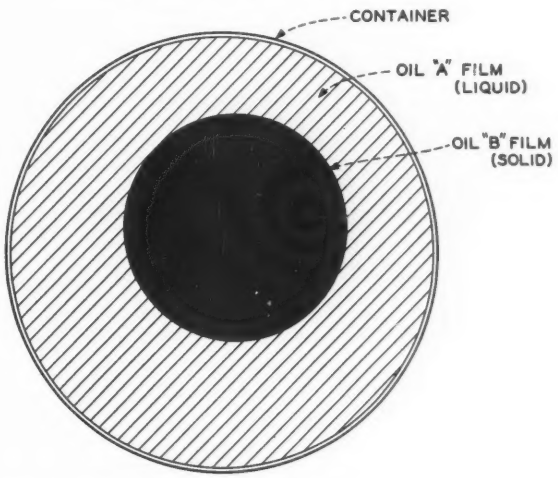

Fig. 5 Solid and liquid phase surface films.

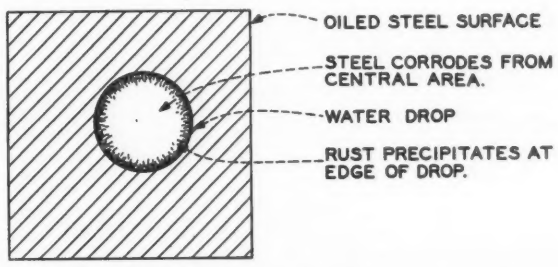

Fig. 6 A rusting pattern for water drops on oiled steel surfaces.

tween the spreading of an oil on water and the rust preventive properties of the lubricant, some general relationships are apparent from the writer's experience. Oils which do not "flash spread" on a water surface do not provide heavy duty rust protection as required in the Hydrobromic Acid Neutralization Test or in the Humidity Cabinet Rusting Test[7]. On the other hand, all oils which do "flash spread" on a water surface are not effective rust preventive oils. It is concluded that a good rust preventive must be sufficiently surface active to enable an oil to spread on water, but at the same time, must provide and preserve an impervious film over the entire area, including the region where oil-film depletion occurs due to the spreading of the oil on water.

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[6]H. W. Harkins: Physical Chemistry of Surface Films. Reinhold Publishing Corp., 1952.

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Patent Abstracts

Prepared by **Ann Burchick** from **OFFICIAL GAZETTE,** Vol. 678, Nos. 1, 2, 3, 4; Vol. 679, Nos. 1, 2, 3, 4; Vol. 680, Nos. 1, 2, 3, 4, 5; Vol. 681, Nos. 1, 2. Printed copies of patents are available from the Patent Office at twenty-five cents each. Address the Commissioner of Patents, Washington, D. C. for copies and for general information concerning patents.

Lubricants, Patent #2,665,252, by C. F. Prutton, assignor to The Lubrizol Corp.

A lubricating composition comprising a major amount of an oil of lubricating viscosity and about 0.5 to 10% of a metal salt of paraffin wax-substituted diphenyl oxide sulphonic acid sulphide.

Mineral Oil Containing 1, 2-Dialkoxy Benzene as an Oxidation Inhibitor, Patent #2,665,253, by W. C. Hollibaugh, assignor to Sun Oil Co.

A composition comprising: a major proportion of mineral lubricating oil suitable for use under severe temperature conditions; and a minor proportion constituting an oxidation-inhibiting quantity of a 1, 2-dialkoxy benzene wherein the alkoxy groups contain 1-9 carbon atoms.

Oxidation Inhibited Mineral Oil, Patent #2,665,254, by W. J. Coppock, assignor to Sun Oil Co.

A lubricating composition comprising: a major proportion of mineral lubricating oil suitable for use under severe temperature conditions; and a minor proportion constituting an oxidation inhibiting quantity.

Separation of Wax-Like Constituents from Oil with a Complexing Agent in the Presence of Water, Patent #2,666,020, by G. B. Arnold, H. V. Hess, J. K. Truitt & J. W. Fitzwilliams, assignors to The Texas Co.

In the separation from a lube oil of constituents which form crystalline complexes with urea, the method which comprises subjecting said lube oil to contact with urea in the presence of water and an added normal paraffin hydrocarbon containing about 7 to 14 carbon atoms per molecule with the result that the complex-forming constituents in the lube oil enter into crystalline complex formation with urea, and separating resulting crystalline complex from the oil.

Lithium Soap Grease Containing Methacrylate Ester Polymer for Bearing Noise Supression, Patent #2,666,033, by J. P. Dilworth, W. J. Finn, & O. P. Puryear, assignors to The Texas Co.

A lubricating grease for anti-friction bearings comprising essentially a lubricating base consisting of at least a major proportion of an oil-soluble high molecular weight high boiling liquid aliphatic dicarboxylic acid ester within the lubricating oil viscosity range and possessing lubricating properties, about 10-25% by weight based on the grease of a lithium soap of soap-forming fatty material containing at least 50% by weight on the basis of the fatty material of a hydroxy soap-forming material selected from the group consisting of 12-hydroxy stearic acid and hydrogenated castor oil, said soap thickening said lubricant base to a grease-like consistency suitable for ball and roller bearing lubrication, said grease being normally subject to producing a high pitched objectionable noise when employed for the lubrication of a ball bearing rotated at high speed, and about 0.3-5% by weight based on the grease of a polymerized n-alkyl ester of methacrylic acid wherein the said n-alkyl group contains from 8 to 12 carbon atoms, said polymerized ester in 30% solution in toluene having a kinematic viscosity at 100 F. within the range of 80-2000 centistokes and being incorporated in said grease by stirring at a temperature in excess of about 290 F. for a period of time effective to reduce said noise to a satisfactory intensity.

Lubricating Compositions, Patent #2,666,743, by E. W. Brennan, assignor to The Pure Oil Co.

A lubricating composition comprising a mineral lubricating oil having incorporated therein, in an amount sufficient to exhibit bearing corrosion, an oil-soluble compound.

Sulfurized Grease Compositions, Patent #2,666,744, by J. A. Dixon, assignor to California Research Corp.

A grease composition comprising a major proportion of an oil of lubricating viscosity and from 3% to 50% of a sulfurized metal soap thickening agent obtained by reacting sulfur with a metal soap of an unsaturated fatty acid and containing from 0.25 to 1.0 atom of sulfur per double bond.

Corrosion Preventing Agent, Patent #2,666,745, by L. V. Mullen, Jr. & J. M. Boyle, assignors to Standard Oil Development Co.

A hydrocarbon oil containing a corrosion inhibiting amount of a product obtained by reacting together substantially equimolar amounts of a dialiphatic hydrocarbon substituted cyanamide, containing 1 to 30 carbon atoms in each aliphatic group and containing at least one unsaturated grouping in at least one of such aliphatic groups, and an amine selected from the group consisting of primary and secondary aliphatic and cycloaliphatic amines containing 1 to 30 carbon atoms at a temperature of 100-250 C., and sulfurizing such reaction product by reacting the same with elemental sulfur until 10 to 30% of sulfur is combined therewith.

Lubricating Oil Composition, Patent #2,666,746, by J. C. Munday & D. T. Rogers, assignors to Standard Oil Development Co.

A lubricating oil composition comprising a major proportion of mineral oil and a small amount, sufficient to depress the pour point thereof, of an oil-soluble copolymer of a vinyl ester of a fatty acid having from 2 to 18 carbon atoms and a dialkyl fumarate wherein each alkyl group ranges from not less than 10 to not more than 18 carbon atoms.

Mineral Oil Composition Containing Copolymers of Itaconic Acid Esters and a Vinyl Ester of a Fatty Acid, Patent #2,666,747, by J. H. Bartlett, assignor to Standard Oil Development Co.

A lubricating composition consisting essentially of a waxy mineral oil having combined therein from 0.01 to 10.0% by weight, based on the weight of the total composition, of a copolymer of from about 270 to 144 parts by weight of an itaconic acid ester having from 10 to 18 carbon atoms in each ester group and from about 75 to 30 parts by weight of a vinyl ester of a fatty acid having from 2 to 18 carbon atoms, said copolymer having a molecular weight within a range of from 2,000 to 20,000.

Lubricating Compositions, Patent #2,-

(Continued on page 171)

LABORATORY EVALUATION OF METAL-FORMING LUBRICANTS

by R. S. Barnes & T. H. Cafcas*

A Tensile-Test Machine has been adapted, by proper choice of test-piece size and die design, for use in evaluating lubricants for cup drawing, wire drawing and rolling. Effects of temperature can be determined. Although the usefulness of the test is somewhat limited by the low speed range of the machine, evaluation of several lubricants by this test agrees with performance in the field.

Metal-forming operations such as drawing, stamping, and rolling are finding wider use. A growing number of new ferrous and non-ferrous metals are being formed. Moreover, many cutting operations are being replaced with cheaper and faster forming methods. If lubricant suppliers are to provide satisfactory products for all these metal-forming operations, adequate methods for evaluating lubricants must be found.

Forming operations involve plastic deformation of the metal[1]. Unit pressures of 5,000 to 500,000 pounds per square inch are encountered[2]. Under the boundary-friction conditions that exist at these pressures, extensive metal-to-metal contact occurs between the metal and the die.

Actual performance under service conditions is the best test of a lubricant for a given use. However, full-scale tests rarely can be run because they are costly and time-consuming and because production equipment seldom is available for test purposes. Most problems of metal-forming lubrication have been solved by "cut and try" methods or by making educated guesses. After a workable solution to a problem has been adopted, further tests usually are impossible because of the pressure of production schedules and cost. Hence, "on the job" solutions have contributed little broad knowledge and understanding of forming lubricants.

Laboratory test machines, such as the Almen, 4-Ball, Falex, Stick-Slip and Timken, have proved helpful in evaluating lubricants for many applications involving boundary friction. However, none of these machines has been found adequate for appraising metal-forming lubricants. A tensile-testing machine appeared worthy of investigation because, with suitable accessories, it could perform small-scale metal-forming operations. The operations would more closely simulate service conditions than do the film-strength and friction tests previously used. Development of this approach to the problem has led to a useful laboratory test for metal-forming lubricants.

EQUIPMENT. Several tensile-testing machines could be adapted to do the job[3]. An Instron Tensile Testing Instrument (Model TT-C; Instron Engineering Corp., Quincy, Massachusetts) was chosen because of its sensitivity and versatility. The Instron machine is shown in Fig. 1. The crosshead is moved up or down at uniform speed by two servo-controlled drive screws. Speeds of 0.02 to 20 inches per minute can be selected. Bonded-wire strain gages, fixed to the upper or lower stationary beams, measure tensile or compression loads applied to test samples. Interchangeable strain gages permit sensitive measurements of loads up to 5,000 pounds. Forces exerted on the strain gages are recorded continuously against the distance the crosshead travels. Varying degrees of magnification of the force-distance curve on the recorder are possible by selection of chart speed. The drawing work is calculated in foot-pounds by integrating the area under the force-distance curve.

The Instron machine was adapted to evaluate drawing lubricants by attaching a die assembly to the lower or compression strain gage. The punch was fastened to the under side of the crosshead. This set-up is shown in Fig. 2.

Wire-drawing lubricant tests were made by suspending a die from the upper or elongation strain gage. The wire-grip was attached to the upper side of the crosshead. This apparatus is illustrated in Fig. 3.

The diameter of the test piece, for a particular metal, and the per cent reduction obtainable in this test are limited by the load capacity of the machine. These limitations fix the diameter of the die.

LUBRICANT TESTING. Lubricants for three metal-forming operations have been tested on the Instron machine. Aluminum redrawing lubricants were studied using the stamping adaptation. Brass-rolling and steel-drawing lubricants were in-

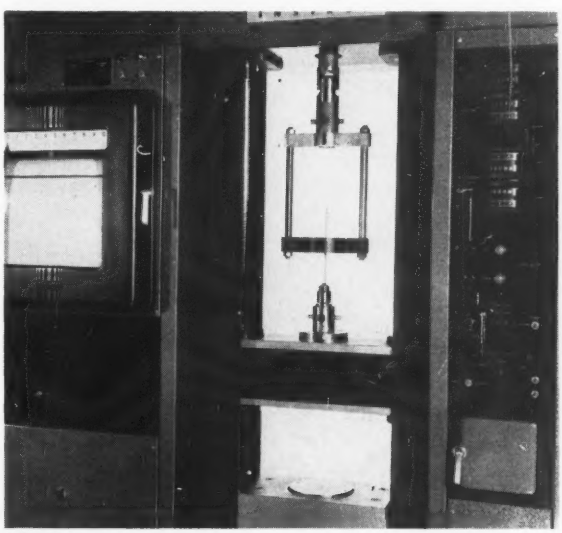

Fig. 1

*Standard Oil Co. (Ind.), Research Dept., Whiting, Ind.

This paper was sponsored by the ASLE Technical Committee on Fluids for Metal Working, and presented at the ASLE 9th Annual Meeting, Cincinnati, April 6, 1954.

vestigated with the wire-drawing setup. Rolling lubricants were tested by drawing wire because the reduction processes that occur in drawing wire through a die are similar to those met in passing a sheet through rolls. For two of these operations, redrawing aluminum and rolling brass, some plant performance data were available with which to compare results obtained in the laboratory. Some commercial lubricants for drawing steel were tested to obtain a base line for further studies.

The criteria of lubricant performance used in these tests were surface finish of the drawn piece and work done in drawing.

Lubricants for Redrawing Aluminum. Redrawing cups is an intermediate step in fabricating aluminum shot-gun shells. Cup blanks, extruded from aluminum sheet, are forced through a series of dies to the desired diameter, length and wall thickness. The diameter of the cup blanks, initially 0.514 inch (average), is reduced to 0.462 inch. The average initial length is 2.30 inches; the final lengths range from 2.48 to 3.38 inches and depend, at least in part, on the lubricant used. Initial wall thickness is 0.0258 inches average and is reduced to 0.0232 inches average.

It was possible to use production dies, punch, and cups in this study. Three dies were used to draw the aluminum cups. Two sets of dies were employed, one of chrome-plated tool steel and the other of tungsten carbide. The working dimensions were:

		Full Angle, °	
Die	Diameter, Inches	Steel	Carbide
Top	0.472	12	18
Middle	0.463	12	6
Bottom	0.462	12	12

The test procedure consisted of coating the cup, punch and dies with lubricant, placing the cup with the closed end down in the top die, and lowering the punch to force the cup through the dies. The cup then was stripped off the punch and was measured and rated for surface finish. After each test, the dies and punch were inspected for metal pickup and were polished with crocus cloth until all visible evidence of pickup was removed. Both the dies and punch were rinsed with benzene and acetone, air-dried and returned to service.

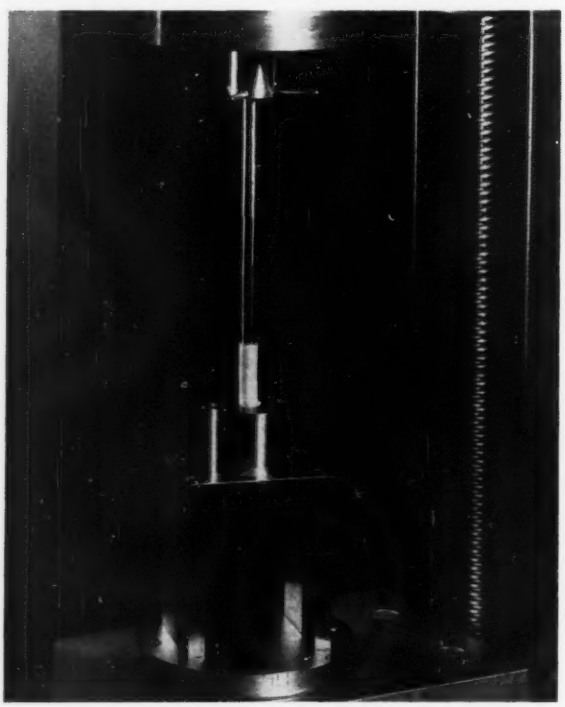

Fig. 2

The three-die system poses a difficult task for a lubricant. A satisfactory lubricant will form a film that adheres to the metal as it goes through all three dies. No additional lubricant can reach the metal as it passes from the first to the second and third dies. Although the greatest change in dimensions of the cup occurs in passing through the first die, most of the drawing work is done in the middle die. This fact was demonstrated by passing pieces through the dies one at a time; the results are given in Table I.

Instron machine results obtained by redrawing aluminum with a number of different lubricants are shown in Table II. Steel dies were used. Two types of lubricants were studied; dry-film and fluid.

Lubricant 1, a commercial dry-film lubricant that gave poor surface finishes in service, showed high drawing work and poor surface finish in our test. Lubricant 2 also was unsatisfactory. In general, dry films that deposited in hard or brittle layers gave poor results. Lubricants 3 and 4 are examples of dry films that gave smooth, bright finishes and low drawing work. These films were soft and pliable.

In testing fluid lubricants, a relationship between viscosity and drawing work was found. Lubricants 5, 6 and 7, uncompounded mineral oils, show decreasing drawing work with increasing viscosity. However, none of these fluids gave satisfactory surface finishes. Synthetic hydrocarbon polymers, Lubricants 8, 9, and 10, were used to extend the viscosity range. Lubricant 8, comparable to Lubricant 5 in viscosity, showed similar drawing work. Lubricant 9 gave no significant reduction in

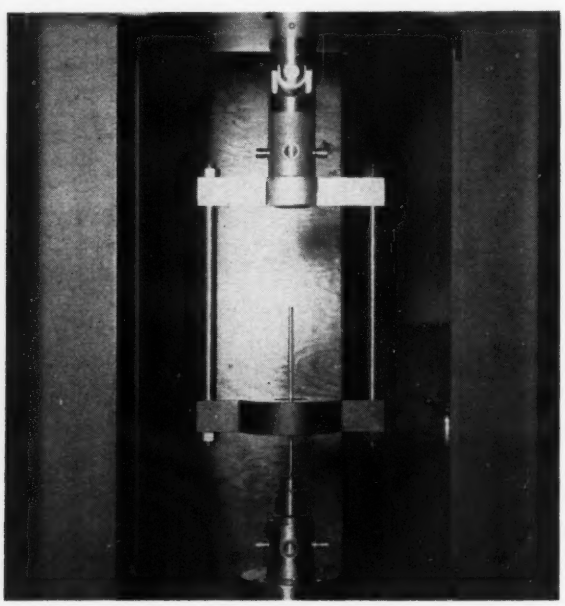

Fig. 3

Lubricant	Die (Location)	Drawing Work, Ft.-Lbs.	
		Steel Die	Carbide Die
Mineral Oil 95 SSU at 210 F.	Top	78	57
	Middle	100	109
	Bottom	43	0
Synthetic Polymer 1000 SSU at 210 F.	Top	73	69
	Middle	86	121
	Bottom	43	0

Table I Aluminum redrawing; passing same cup through dies one at a time.

drawing work over that obtained with Lubricant 7, but did give a smooth, bright surface finish. Lubricant 10, of very high viscosity showed high drawing work similar to the low viscosity oils.

General experience with aluminum-forming processes indicated that the performance of mineral oils containing fats, fatty acids, chlorine compounds, or graphite would be superior to the oil alone. Lubricants 11, 12, 13, and 14, containing these additives, all gave poor surface finishes and only Lubricant 14, containing graphite, showed any less drawing work than the uncompounded oil. These results were confirmed, qualitatively, in the specific commercial operation being studied.

Best results were obtained with emulsified products. Lower drawing work and smoother finishes were obtained with emulsified blends than with these formulations in the absence of water. For example, Lubricant 16 gave better results than Lubricant 15.

Carbide dies were superior to steel dies. Table III shows a comparison of the two types of dies with several lubricants. In general, less drawing work was required with the carbide dies. They also produced cups with better finishes and greater elongations.

There was a correlation between the drawing work required to redraw a cup and the condition of the surface of the finished cup. Severely scratched and galled surfaces generally occurred with high drawing work. Smooth, dull matte finishes were obtained with low values. An intermediate zone of drawing work values exists in which finished cups can have surfaces that are either mildly scratched, smooth and bright, or smooth and dull.

The repeatability of the results varied with the drawing work value. At low and intermediate values, the drawing work results are repeatable within 5%; at high values the repeatability is 10%.

Lubriaant	Application	Surface*	Drawing Work, Ft.-Lbs.
1. Wax emulsion	Dry film	Sc, Ga	187
2. Heavy residual oil	Hot dip, dried film	Ga	211
3. Wax emulsion	Dry film	Sm, B	155
4. 5% Polymer 45% Heavy residual oil 50% Stoddard solvent	Dry film	Sm, B	173
5. Mineral oil, 50 SSU at 210 F.	Fluid	Sc, Ga	277
6. Mineral oil, 95 SSU at 210 F.	Fluid	Sc	242
7. Mineral oil, 180 SSU at 210 F.	Fluid	Sc	191
8. Synthetic polymer, 40 SSU at 210 F.	Fluid	Sc	258
9. Synthetic polymer, 1000 SSU at 210 F.	Fluid	Sm, B	185
10. Synthetic polymer, 3000 SSU at 210 F.	Fluid	Sc	237
11. 90% Mineral oil No. 6 10% Fatty oil	Fluid	Sc, Ga	291
12. 97% Mineral oil No. 6 3% Fatty acid	Fluid	Sc, Ga	251
13. 97% Mineral oil No. 6 3% Chlorinated wax	Fluid	Sc	254
14. 95% Mineral oil No. 6 5% Graphite	Fluid	Sc	221
15. 45% Mineral oil No. 7 50% No. 9 5% Emulsifier	Fluid	Sm, B	185
16. 50% No. 15 50% Water, 150 ppm hardness	Fluid	Sm, D	121
*Sc - scratched Ga - galled	Sm - smooth B - bright	D - dull	

Table II Effects of lubricant composition on redrawing aluminum.

Lubricants for Rolling Brass and Drawing Steel. In the wire-drawing tests, one end of the test wire was swaged or turned down to permit threading the wire through the die. The swaged end then was clamped in a chuck attached to the upper side of the crosshead. A tungsten carbide die, with an inside diameter of 0.182 inch and a half-angle of 4°, was used. Seven wires, 8 inches in length, were drawn with each lubricant.

Brass-rolling lubricants are soluble oils with enough lubricity to prevent sticking and burnishing of the brass sheet as it passes through the rolls. In addition, these oils must not stain the brass in sub-

Lubricant	Steel Die			Carbide Die		
	% Elongation	Surface Scratches	Work, Ft.-Lbs.	% Elongation	Surface Scratches	Work, Ft.-Lbs.
1. Mineral oil, 95 SSU at 210 F.	32.3	Medium	242	35.0	Fine	166
2. Synthetic polymer, 1000 SSU at 210 F.	28.8	Very fine	185	35.7	Negligible	190
3. 50% No. 1 50% No. 2	31.2	Medium	234	39.6	Fine	191
4. Mineral oil, 180 SSU at 210 F.	24.0	Medium	191	40.4	Medium	174

Table III Comparison of steel and carbide dies for redrawing aluminum

Lubricant	Drawing Work, Ft.-Lbs.*	Surface Scratches	Mill Power Requirement
A	480 ± 20	Fine	Highest
B	476 ± 22	Very fine	Middle
C	465 ± 9	Very fine	Lowest
D	448 ± 8	Very fine	
E	452 ± 3	Very fine	
*95% Confidence limits.			

Table IV Evaluation of brass-rolling lubricants.

sequent annealing steps and must have a minimum tendency to form copper soaps, which would reduce the stability of the emulsion.

The brass wire used was SAE No. 72 free-cutting brass with a diameter of 0.218 inches. The lubricants were tested as emulsions containing one part of test oil and four parts of water.

Rolling-mill power requirements for three brass-rolling lubricants were available as a result of earlier work. No previous laboratory test had aligned these oils in the same order of effectiveness as that obtained in service. Table IV shows a comparison of these oils on the Instron machine. These tests placed Lubricants A, B, and C, in the same order shown by the mill tests. Lubricants D and E, developed as a result of these tests, require lower drawing work than the best of the previously used oils. The satisfactory oils all show a small spread in drawing work.

The steel wire used was SAE No. 1020 steel with a diameter of 0.207 inches. The swaged wire was bright-annealed under nitrogen at 1650 F., for one-half hour, pickled in 18% hydrochloric acid for one minute, and rinsed twice in warm water. The wire then was wiped dry.

Eleven commercial steel-drawing lubricants were tested. Instron machine results obtained with these oils are shown in Table V. These lubricants represented widely different compositions of soaps, fats, fatty acids, fillers, sulfur or sulfurized compounds, and chlorinated compounds in petroleum oils. All gave satisfactory surface finishes. The lubricants can be divided into three levels of drawing work requirements: low, Lubricant 1; intermediate, Lubricants 2 through 4; high, Lubricants 5 through 11. Lubricant 1, showing the lowest drawing work, is composed entirely of fats and free fatty acids. Lubricants 6 and 9 caused high drawing work. Lubricants 7 and 10 show that addition of small amounts of graphite to Lubricants 6 and 9 did not lower the drawing work of the base oils. Lubricant 3 is composed of 50% of a sulfurized fat and 50% of an intermediate oil, Lubricant 2, and shows slightly lower drawing work than Lubricant 2. Lubricant 8, a blend of a small amount of an intermediate oil, Lubricant 5, with Lubricant 9 shows no improvement in work over the high work oil. These results supply a base line from which to begin a detailed and systematic study of steel-drawing lubricants.

Lubricant	Drawing Work, Ft.-Lbs.	Surface Scratches
No. 1	232 ± 5	Very fine
No. 2	263 ± 6	Very fine
No. 3	259 ± 6	Very fine
No. 4	278 ± 6	Fine
No. 5	293 ± 6	Very fine
No. 6	301 ± 4	Very fine
No. 7	301 ± 4	Very fine to fine
No. 8	309 ± 5	Fine
No. 9	309 ± 6	Very fine
No. 10	308 ± 4	Very fine
No. 11	315 ± 6	Very fine

Table V Evaluation of commercial steel-drawing lubricants.

CONCLUSIONS. Correlation of Instron machine test results with service experience appears satisfactory. While it is difficult to obtain plant data on lubricants, such information as we now have on oils for redrawing aluminum and rolling brass agrees with the Instron test results. Additional plant tests are under way to obtain more data.

The drawing work required with a poor lubricant may be more than 50% greater than with a good one. However, as in the case of aluminum where a bright surface is desired, surface finish requirements may dictate the use of a lubricant of intermediate rather than the lowest possible drawing work.

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Current Literature

Some Factors to be Considered in an Evaluation of Corrosion & Corrosion Inhibitors, by E. J. Schwoegler; **Laboratory Performance Testing of Petroleum-Base Rust Preventives,** by H. A. Ambrose, E. E. Fisher & E. S. Francis; **Corrosion Inhibitor Applications in the Petroleum Industry,** by F. M. Watkins & R. I. Lindberg; National Petroleum Association, 51st Annual Meeting, Sept. 17, 1953, 31 pp.

Some of the factors involved in corrosion have been reviewed with specific reference to a fairly simple problem of ball bearing storage. A more complex situation is presented if the ball bearings are stored in a brass ring. Petroleum base rust preventives may be film-forming materials or rust-inhibiting oils. Laboratory methods for testing rust preventives, other than the well-established ASTM D665-52T, are not generally suitable for examination and approval of samples from commercial production. In general, laboratory tests for rust-preventive properties are not sufficiently reproducible to be reliable for use in purchase specifications. It is urged that those who use laboratory performance tests for development of rust preventives or for purchase specifications do so with caution. The cost of adding hydrocarbon soluble inhibitors is greater than for water soluble inhibitors when protection of a short pipe line is the only consideration. The reverse is true, however, for a long pipe line since the hydrocarbon soluble type need be added only once, while the water soluble type must be supplemented by addition of more inhibitor about every 50 miles. Table II lists most of the equipment through which a batch of products passes in its journey from production to ultimate consumption. Recently, rust preventive oils have been successfully used in compressed air lines.

Materials for O-Ring Seals — Their Properties & Selection, by E. L. Carlotta; Materials & Methods, Vol. 38,

(Continued on page 167)

LUBRICATION SYSTEMS FOR HEAVY CLOSED DIE FORGING PRESSES

by W. J. Polny* & R. G. Sturm**

This paper discusses the automatic lubrication systems developed for the Loewy 50,000 and 35,000 ton forging presses. Because of the size, design and operating features of these machines ,the conventional methods of lubrication could not meet all specifications. The problems posed required a fresh approach and the resultant solutions are described here after a brief outline of the press design and operation.

The lubrication systems described here are for the 50,000 ton "Major" and 35,000 ton "Minor" closed die forging presses designed and being built by Loewy-Hydropress, Inc., for the U. S. Air Force Heavy Press Program. The design details and operating features of these presses have been given in a number of technical and general magazines. A brief description is given here in order to follow the lubricating problems and the solutions.

PRESS DESIGN. The 50,000 ton press "Major" (see Fig. 1) is 110 ft. high, of which 60 ft. are in the pit and 50 ft. are above ground. It measures approximately 45 ft. along one of its sides and 110 ft., including the sliding table, on the other side. For nomenclature see Fig. 2.

The weight of the press rests on two main press supports which are anchored to the foundation. One support is fixed while the other is pivoted, much like a bridge span, to allow thermal expansion. Forging loads are applied by nine main cylinders which act through ram footings and pressure plates through lower crosshead beams to the six laminated columns. These 40½" square columns tie the lower moving section of the press to the upper moving entablature. The forging loads are thus a self-contained force and are not transferred to the foundation except for dynamic conditions.

The sliding table facilitates operation of the press by making it possible to remove the bolster plate with the die set and dies from between the press platens. The sliding table consists of a stationary frame with slideways for the bolster plate and guides for the push bar and moving crosshead. Attached to the crosshead are the feed cylinder and return cylinder rams which operate the bolster plate by means of the push bar with lock pin arrangement.

The 35,000 ton press "Minor" (see Fig. 3) has the same basic design, although it is proportionally smaller than "Major." It has only four columns and eight smaller main cylinders. This press has two side cylinders for the upsetting work.

OPERATION OF PRESSES. The presses are powered by a hydro-pneumatic accumulator system, using water as the hydraulic medium. Soluble oil additive acts as a lubricating and rust preventive agent.

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**Auburn Research Foundation, Alabama Polytechnic Institute, Auburn, Ala.

This paper was sponsored by the ASLE Technical Committee on Fluids for Metal Working, and presented at the ASLE 9th Annual Meeting, Cincinnati, April 7, 1954.

A normal operating cycle of these presses consists of a downward forging stroke, 6 ft. maximum, with pressure supplied by the main cylinder rams. The return stroke is performed by a set of return cylinders with the capacity to raise the combined weight of lower crosshead beams, columns and upper entablature.

Certain types of work will require removal of the bolster plate with the die set and dies. A primary stroke of over 20 ft. and a secondary one of about 8 ft. give the bolster plate almost complete press clearance. When the sliding table is used, an operating cycle consists of an "out" and "in" stroke of the bolster plate over the sliding table and a forging and return stroke of the press proper.

LUBRICATING SYSTEMS. The physical size of these presses, larger than any built previously, created challenging problems in lubrication.

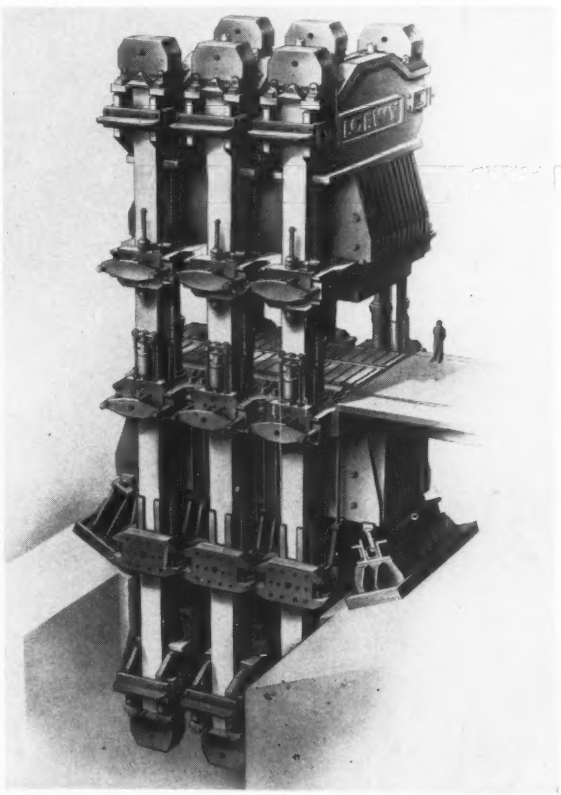

Fig. 1 Visualization of 50,000 ton capacity closed die forging press.

"Major" (see Fig. 4). The ram footing pressure plates, which operate under pressures up to 16,000 p.s.i., require uniform feeding at all points of contact. This is accomplished by 36 inlets, 4 per plate, which feed lubricant into a network of grooves.

The column guides, with a total area of contact of approximately 135,000 sq. in., combined with a 6 ft. stroke, require proper distribution of lubricant. This is achieved by locating a total of 96 lubricating points on lower and upper guides on each side of all six columns.

Since the pressure plates and lower column guides are located close to each other, in lower elevation, they are lubricated by one system supplied from its own pump station. This is System No. 3.

The upper column guides, located near the sliding table, in elevation, are served by System No. 2 through 48 inlets. This system includes a sliding table branch line, connected to the rest of the system by means of a solenoid operated air-grease shut-off valve. This arrangement is necessary because the sliding table frame requires lubrication only when the bolster plate is in operation. Its lubrication cycle has to be tied-in with that of System No. 1 which serves the bolster plate. This branch line with a total of 20 inlets supplies lubricant to the moving crosshead guides on the sliding table stationary frame.

System No. 1, with its own pump station, takes care of the bolster plate and all the other parts that are attached to it and travel with it. Due to the long and exposed slideways on the sliding table for the bolster plate, push bar and apron plate, unavoidable waste and spillage into the press pit would occur if grease were shot into uncovered inlets. Therefore, an arrangement was made to feed the lubricant into moving parts while they are at their normal extreme position. By charging the grease under pressure into covered grooves, a travelling reservoir of lubricant is provided which unloads its contents as it moves. The bolster plate, push bar and apron plate are lubricated in this manner.

This arrangement was achieved by using a detachable coupling, the plug end of which is mounted on one of the moving parts (the bolster plate) and the socket end on a stationary part (the lower platen). Both ends of the coupling are fitted with check valves.

The above moving parts slide over an area of over 85,000 sq. in. and as they move they discharge the contents of their grooves on the slideways. Grooves close to each end of the moving part provide a grease deposit for the return trip. A total of 30 lubrication points in the moving parts supply lubricant to the grooves. After each stroke the detachable coupling connects the lines and the limit switch starts the pump of System No. 1, for one complete lubrication cycle.

All together, on the "Major" press, there are about 250,000 square inches of surface over which moving parts slide. A total of 182 inlets feed the lubricant into the grooves served by the same number (by coincidence) of adjustable, indicating and measuring valves of different sizes and capacities. These valves have been selected to permit a setting which will discharge the exact amount of lubricant. The total length of main lubrication lines is more than 2,000 feet, consisting of 1" and 1½" pipe. A total of about 1,400 lbs. of grease is required to fill up the lines and grooves of all three systems.

Each of the three lubricating systems incorporates the dualine loop principle and each is served from a separate heavy duty automatic pump station, driven by a 1½ HP motor. The lubricant specified is No. 1 grade grease containing graphite.

In addition to the above three automatic sys-

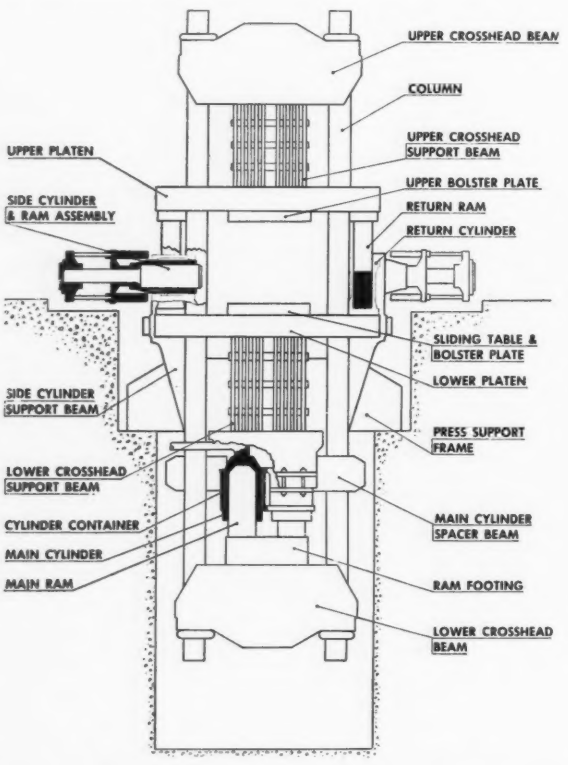

Fig. 2 Nomenclature of principal components of heavy hydraulic forging press.

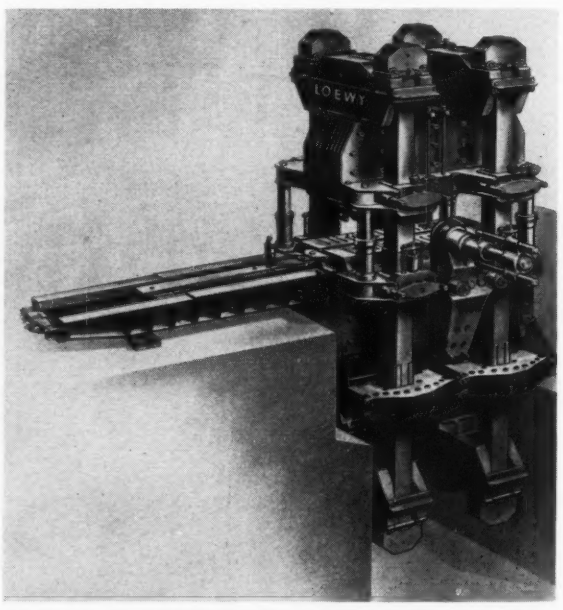

Fig. 3. Visualization of 35,000 ton capacity closed die forging press.

tems there is a small hand operated system which lubricates the main control cam shaft bearings and the rocker arms. This system is not connected with the automatic systems, since it is located some distance from the press.

"Minor." The smaller Loewy forging press of 35,000 tons, is lubricated in the same manner as "Major," but being proportionally smaller, needs only two automatic systems (see Fig. 5) supplied from two pump stations of the same capacity as "Major."

System No. 1 takes care of the bolster plate, push bar and the apron and also the stationary frame of the sliding table.

System No. 2 provides lubrication for the upper and lower column guides and main cylinder pressure plates.

The total area of lubricated surfaces on the 35,000 ton press is nearly 140,000 sq. in., served by 146 lubricating points. The lubricant is distributed by 69 valves of different sizes and capacities. The lubricating equipment and type of grease used will be similar to that of "Major."

In addition, there are two hand operated lubrication systems serving the main cylinder and side cylinder control valve cams and rocker arms. These are similar to the manual system for "Major" press.

ELECTRICAL CONTROLS. The electrical controls of the three lubricating systems on "Major" operate as follows:

System No. 1. With the bolster plate in place, holding the limit switch in a closed position, the operator starts the pump by a push button located on the main control pulpit. At the same time a solenoid operated valve on the sliding table branch of System No. 2 is automatically opened. A built-in reversing valve limit switch shuts off the pump when the pressure reaches a pre-set value, which will be determined at the trial runs. The pump will not start again until the bolster plate has completed its stroke, closing the limit switch, or until the push button switch is manually pressed "off" and then "on."

System No. 2. With the exception of the sliding table branch line, this system is started by a push button switch on the operator's pulpit, shut off by a reversing valve limit switch, and started again by an electrical timer.

System No. 3 is similar to System No. 2.

Electrical controls on "Minor" are similar to those on "Major;" with the following exception: On this press we do not have the solenoid operated shut off valve and the sliding table branch line is here a part of System No. 1.

It should be noted that neither press can be started before the lubricating systems are energized. Also, a failure in any system sounds an alarm but does not stop the press.

SUMMARY. A summary of this discussion can be given as follows: (1) Dividing the lubrica-

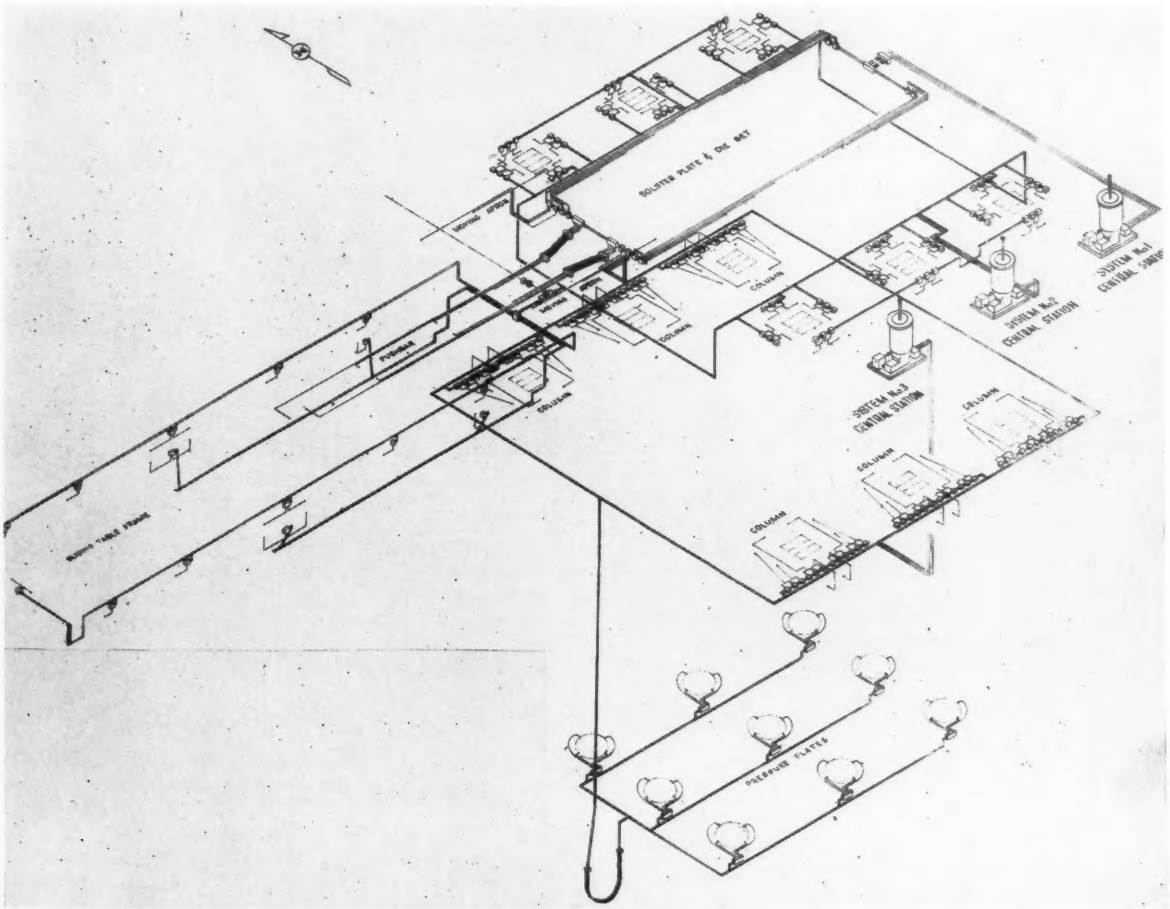

Fig. 4. Diagram of automatic lubrication systems for 50,000 ton die forging press "Major."

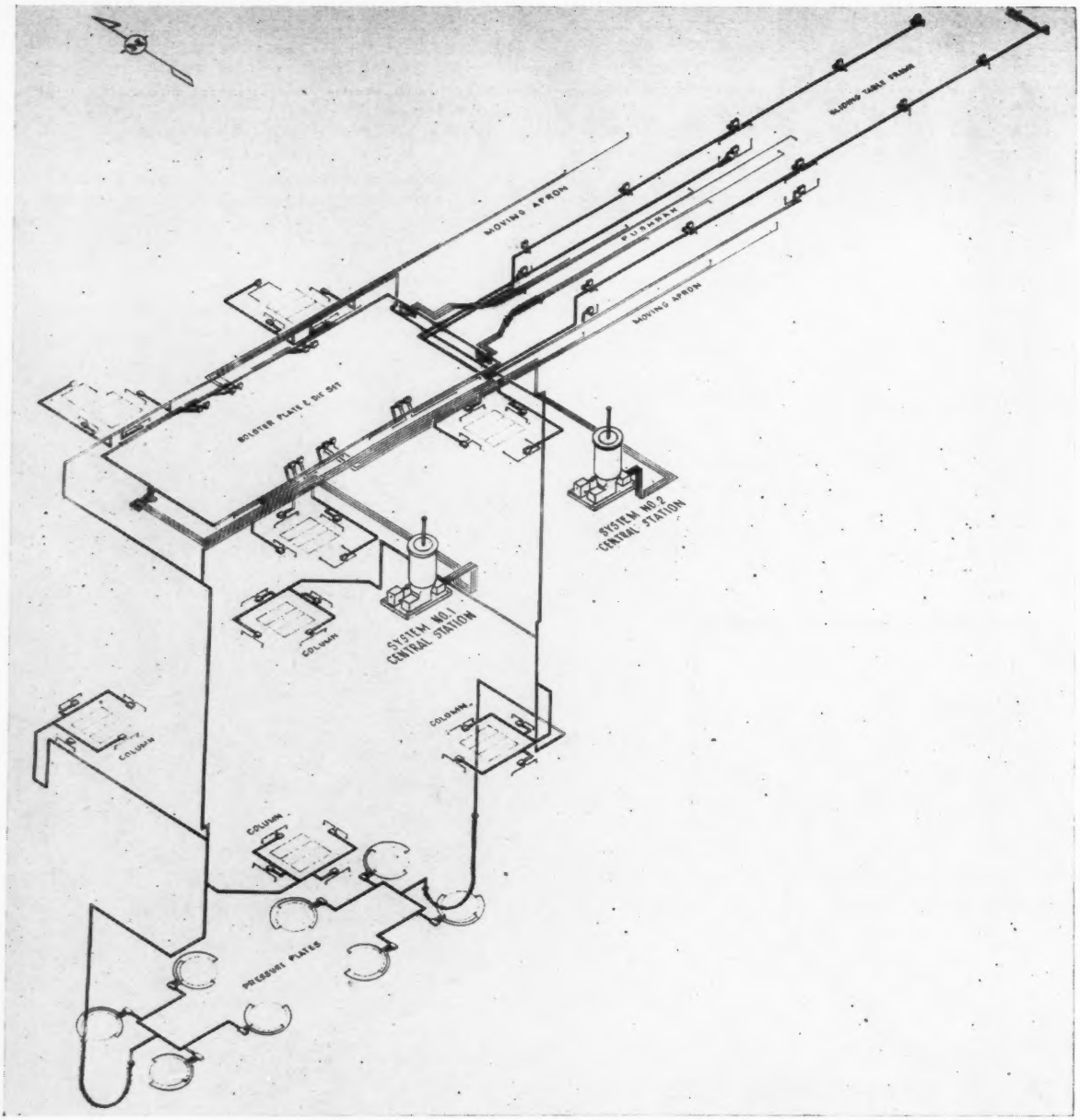

Fig. 5. Diagram of automatic lubrication systems for 35,000 ton die forging press "Minor."

tion requirements into several systems was dictated not only by the size of the presses but also by the fact that the operating cycles of the two main press components are not simultaneous. (2) By providing lubrication through moving components, continuous and uniform lubrication is obtained with maximum efficiency and minimum of waste and spillage nuisance. (3) The automatic interlocking controls eliminate the dissipation of the grease supply when the press proper or its sliding table is not in operation.

Personals

Dr. W. E. Campbell (ASLE 1953-1954 President), formerly with Bell Telephone Laboratories, has joined Brush Laboratories Co., Div. of Clevite Corp., as Director of Chemicophysical Research. His work at Brush Laboratories will be in the direction of basic research in surface physics and chemistry, with special emphasis on friction and wear between rubbing surfaces. Dr. Campbell is Chairman of the Presidential Council of ASLE, and a member of ACS, ASTM, the Special Research Committee on Lubrication of ASME, and the sub-committee on Lubrication & Wear of NACA.

A Conference on Lubrication, sponsored jointly by ASME & ASLE and covering a broad range

(Continued on page 169)

EARLY STAGES OF FRETTING OF COPPER, IRON & STEEL

by D. Godfrey & J. M. Bailey*

In the early stages of fretting (up to 400 cycles), surface damage starts with severe adhesion and this process then initiates other wear phenomena. Plowing is pronounced when adhesion is severe. Oxide debris is formed in a very few cycles if the wear fragments are small but may not be evident if the fragments are large. Films are formed by compacting particles into clearances in the contact area. They form most readily when one of the surfaces is hard. Importance of different wear phenomena varies with the materials fretted and they can occur simultaneously at different points within the contact area.

Fretting, the term applied to the surface damage that occurs when contacting solids experience slight reciprocating slip, is one of the most serious problems of wear existing in machines and metal structures. The wear, pitting, and accumulation of debris caused by fretting can lead to loss of tolerance, increased fatigue susceptibility, and seizure. The later stages of fretting have been studied widely, but there are available only a few incidental observations on the start and early stages of fretting. The resulting lack of understanding of the phenomena occurring early in fretting has been a deterrant to the prevention or mitigation of fretting in general. Research was therefore conducted to obtain more experimental information about the start of fretting and the cause of damage in the first few hundred cycles of fretting of several unlubricated metals.

The materials studied were copper, iron, and steel; and supplementary experiments were made using glass and compacts of copper oxides and iron oxides. Fretting was produced by reciprocating flat specimens in contact with convex specimens at a constant load, frequency, amplitude, and humidity. The procedure included a continuous recording of friction force and a microscopic examination of the fretted contact areas. In specimen combinations with glass flats, fretting was observed microscopically as it occurred. Debris was analyzed by chemical spot tests and surfaces were examined by electron diffraction. The research described herein is reported in greater detail in Refs. 1 & 2.

APPARATUS. The apparatus (Fig. 1) was designed to produce fretting at low frequency so that friction force could be measured and close observation could be made of the start of fretting. A flat specimen, held horizontally by a clamp attached to a dynamometer ring, slid back and forth in contact with a convex specimen. The load was 150-175 grams, and was applied by setting weights on the flat specimen. The linear reciprocating motion of the dynamometer ring and the flat-specimen holder assembly was achieved by a nut traveling on a screw oscillated by a synchronous reversible motor. The velocity of 0.156 inch per minute of the nut was obtained by using a 10-rpm motor to drive a screw having 64 threads per inch. The amplitude of 0.006 inch was controlled by a pair of adjustable limit switches, which actuated a relay that reversed the motor. This combination of amplitude, sliding speed and general dynamics of the apparatus gave a frequency of about 5 cycles per minute.

The relative humidity of the air surrounding the specimens was held to less than 10 percent by enclosing the whole apparatus in a Lucite box and maintaining a flow of clean, dry air through the box during each run. For the experiments in which vertical microscopic observation was made of fretting between a glass flat and a convex metal specimen, rubberized cloth with a hole for the microscope objective was used as the top of the box.

The friction force was measured by a strain gage attached to the dynamometer ring and was recorded by a photoelectric potentiometer. Normal load was measured for each run by determining the upward force required to separate the specimens. The accuracy of measurement of the coefficient of friction (ratio of friction force to measured load) was estimated to be ± 5 percent.

MATERIALS & PROCEDURE. Materials. Electrolytic copper and 99.97 percent pure iron were used as two of the specimen materials because of their purity and established friction characteristics. The copper specimens were annealed to Rockwell F-40 after machining, and the pure iron was hardened to Rockwell B-82 by rolling. One-half-inch diameter commercial balls of approximately 1 percent carbon case-hardened steel and having a superficial hardness of Rockwell C-62 were used as the main steel specimens. Some steel flats were made of drill rod stock containing 1 to 1.15 percent carbon and were either hardened to Rockwell C-60 or annealed to less than Rockwell B-80. Other flats were made of an unhardened tool steel containing 1.0 percent carbon and 1.45 to 1.55 percent manganese. Powder compacts of CuO, Cu_2O, Fe_3O_4, and Fe_2O_3 were made and used. The glass flats were microscope slides.

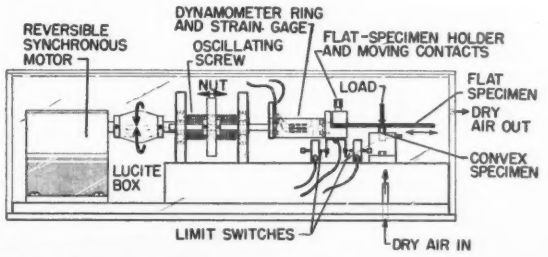

Fig. 1 Fretting apparatus.

*Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio.

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Specimen preparation. Prior to cleaning, all specimens except the glass flats were abraded on 2/0 emery paper to give a uniform surface finish. Consistent and thorough cleaning was of vital importance in obtaining reproducible data. Freedom from grease was indicated for a given material by high initial values of the coefficient of friction. The metals were cleaned by repeated rinsing in pure solvents, followed by immersion in an anodic bath, washing, and drying. Glass was cleaned by scrubbing with glass wool under nitric acid, and the oxide compacts were cleaned by repeated rinsing in pure solvents.

Experimental procedure. The cleaned specimens were mounted in the specimen holders of the apparatus and the load was applied by adding weights. The cover of the Lucite box was put in place and dry air was started flowing through the enclosure. When the relative humidity of the escaping air had dropped to 10 percent, the reciprocating action was started.

For metal against metal combinations, the surfaces were separated and examined microscopically after runs lasting ½, 1, 5, 10, 20, 50, 100, 200 and 300 cycles. New specimens were used for each run. In the case of glass flat specimens, the fretting action was observed microscopically (X75 to X200) as it occurred. Small quantities of debris were identified by chemical spot tests. Electron diffraction was used to determine the chemical composition of metal surfaces before the runs and also to identify debris when possible.

RESULTS. The coefficient of friction was plotted against cycles for each run; the friction curve presented (Fig. 2) for each specimen combination is a smoothed curve drawn through the average of all the runs. A brief correlation of the number of cycles, the observations of the contact area, and the coefficient of friction follows and is presented in more complete tabular form in Refs. 1 & 2. The contact area over which wear was observed was small, varying from 0.002 inch to 0.02 inch in length and width. The phenomena observed during fretting begin in the sequence presented, but the action can be in different stages at various parts of the contact area at the same time. All chemical compositions given parenthetically in the text were identified by chemical spot tests.

Fretting of copper. Copper against glass: Copper was fretted against glass to allow observation of fretting action as it occurred on the metal surface, and the friction results are presented in Fig. 2(a). The coefficient of friction was 1.2 initially, and then increased to a peak value of 1.6 after several cycles with a marked transfer of copper to glass. Increase of area covered by transferred material, some plowing by the transferred film, and formation of loose metallic debris were accompanied by a decrease in the value of μ to 0.6 at the end of 60 cycles. The copper contact area became encrusted with oxide (CuO), and sliding occurred between material adhering to the glass and the oxide crust. Loose black oxide debris was pushed out of the contact area, and a constant coefficient of friction near 0.6 resulted.

Copper against copper: The friction results obtained from fretting annealed copper against copper are also presented in Fig. 2(a). The initial μ values were approximately the same as those obtained during unidirectional sliding (Ref. 3, pp. 80-81). This indicates that the contact between specimens was essentially metal-to-metal during the first few cycles of fretting, although some oxide was no doubt present as ruptured films. The rise in μ during the first five cycles was apparently caused by an increase in the amount of metal-to-metal contact as adsorbed gases and thin oxide films (Cu_2O, < 100 Å thick, as described in Ref. 3, p. 149, unavoidably formed at room temperature) were ruptured and rubbed off.

A reduction in μ to approximately 0.55 was then observed and was associated with plowing and an increasing concentration of metallic, and then CuO debris in and around the contact area.

Specimens of copper ranging in hardness from Rockwell F-40 to F-90 were fretted together. The fact that the friction curves were almost the same over the whole hardness range indicated that, within those limits, hardness had little effect on the behavior of μ. However, greater total damage (as estimated from the diameter of the wear area) was observed with the soft copper than with the hard.

A photomicrograph of a 15:1 taper section of the damaged area on copper after fretting against copper in air for 300 cycles is shown in Fig. 3. The presence of imbedded oxides and severe deformation of the bulk metal below the surface is evident. The damage shown is very similar to that presented in Ref. 4, which was produced by repeated nonreciprocating sliding passes over the same track. This indicates that for copper similar damage results from fretting and from sliding.

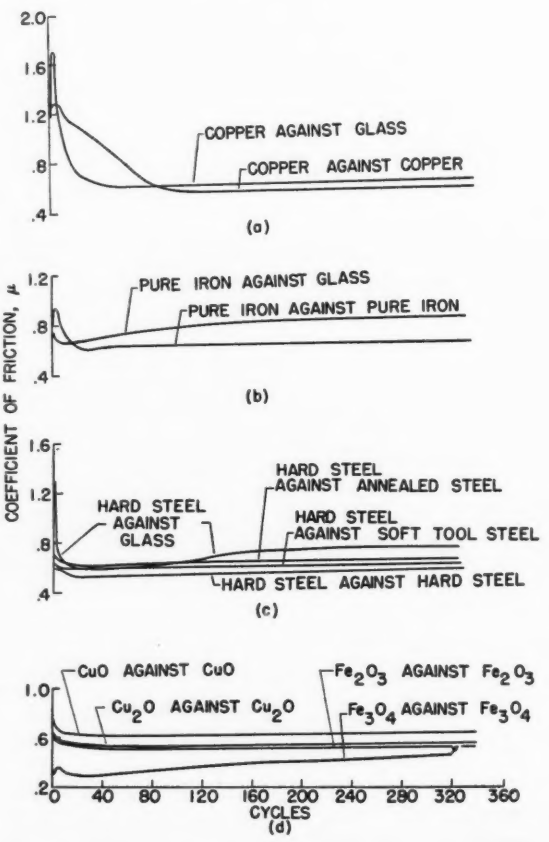

Fig. 2 Coefficient of friction during fretting of various material combinations.

Fretting of iron. Pure iron against glass: The friction results of fretting pure iron against glass are presented in Fig. 2(b). The first half cycle of motion caused extensive transfer of iron (Fe) to the glass and a coefficient of friction greater than 0.75. The transferred metal plowed furrows in the surface from which it came, and the coefficient of friction reduced to a minimum value of 0.66 by the end of 10 cycles. The plowing action was followed by a loosening of the metal fragments adhering to the glass, although spots of brown film (Fe_2O_3) appeared on the glass, continued to adhere, and plowed furrows in the metal.

Loose black metallic debris, slowly accumulated as fragments, were "worked" out of the contact area. After 50 cycles, film appeared on the metal contact area. The spots remaining on the glass changed both in position and in degree of activity, and the value of μ increased gradually from 0.7 to 0.83. After 300 cycles, the amount of film adhering to the metal contact area became essentially constant. Small amounts of rust-colored powder (Fe_2O_3) appeared in some runs in the black metallic debris outside the contact area, and the value of μ was a stable 0.83.

Pure iron against pure iron: The first phenomenon to occur in the fretting of pure iron against pure iron was mutual plowing by large protruding fragments. The action produced a coefficient of friction which averaged 0.82 (Fig. 2(b)). The value of μ in each run then increased to an average peak value of 0.94. Subsequently, the reciprocating action produced loose iron fragments, at first large, and then small, and a decrease in the value of μ to a minimum of 0.6 at 25 cycles.

Some of the small fragments appeared to be trapped in the contact area and pressed into films, whereas other fragments accumulated outside the contact area as loose black metallic debris. After 100 cycles, brown film appeared in the contact area, black debris was occasionally found compacted in the contact area, and the value of μ increased slightly to a stable 0.64. Increasing amounts of loose black metallic debris accumulated around the contact area. After 300 cycles, the contact area was covered by brown-black film which varied in thickness, and traces of rust-colored debris (Fe_2O_3) were occasionally found, in the black debris. A photomicrograph of a 15:1 taper section of the damaged area on pure iron after fretting against pure iron for 400 cycles is shown in Fig. 3. The presence of black debris on the surface and severe deformation of the metal below the surface is evident. However, the debris is not imbedded in the deformed metal as was the case for copper.

Fretting of steel. Steel against glass: Examination of Fig. 2(c) shows that the first sliding motion of glass flats on hard 1-percent-carbon steel convex specimens produces a coefficient of friction greater than 1.2. Brown film (Fe_2O_3) transferred to the glass, and the amount increased with each half cycle. Thickened portions of the film, formed by compacting of fragments against the glass, plowed the steel to form shallow furrows, and the value of μ decreased to a minimum of 0.6 at 20 cycles. Loose rust-colored debris appeared outside the contact area, and parts of the film ceased to move with the glass. The oxide film transferred to glass in the fretting of steel against steel adheres more tenaciously than do the iron fragments which transfer at the start of fretting of iron against glass. From 60 to about 200 cycles, the steel contact area was plowed by a few spots of thick film still adhering to the glass. The spots disappeared as the areas of actual contact moved from one location to another. After 200 cycles, the value of μ rose to 0.75 to 0.77, the amount of film in the contact area became constant, and the amount of loose, rust-colored debris (Fe_2O_3) steadily increased.

Steel against steel: The friction curves obtained in the fretting of hard 1-percent-carbon steel convex specimens against hard and soft (annealed) 1-percent-carbon steel flats and soft tool-steel flats may be seen in Fig. 2(c). In all steel-against-steel runs, fretting started with a value of μ from 0.6 to 0.7. Thin patches of film were observed during the first few cycles. An increase in the quantity of film and in the amount of plowing was associated with a reduction in friction from the higher values to 0.52 to 0.61 in 5 to 30 cycles. The film formation and plowing were followed by the appearance of small loose oxide particles, some of which were trapped in the contact area. The value of μ increased slowly to a value from 0.58 to 0.65 by 300 cycles. Rust-colored and a small amount of black-appearing debris accumulated around the contact area. Chemical tests revealed only Fe_2O_3 in the debris.

Softer steel specimens always suffered more

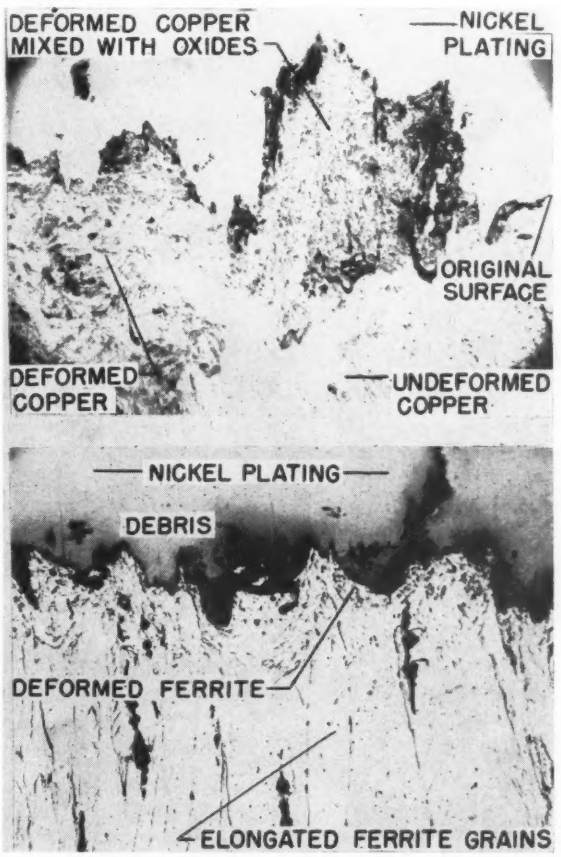

Fig. 3 Photomicrograph of taper section of fretted areas. Copper specimen fretted against copper for 330 cycles (top). Pure iron specimen fretted against pure iron for 400 cycles (bottom). Horizontal magnification, 400X; vertical magnification, approximately 6000X.

pronounced plowing. In addition, loose rust-colored debris (Fe_2O_3) appeared within 10 cycles in the case of hard steel-hard steel combinations, but not until after about 100 cycles in the case of hard steel-soft tool steel combinations. The rate of wear, as estimated from the change in area of the wear spot, was found to be the same for all three steel specimen combinations.

Fretting of oxide powder compacts against oxide powder compacts. Copper oxide compacts: CuO compacts were fretted against CuO compacts, and Cu_2O compacts were fretted against Cu_2O compacts, to determine the type of damage and frictional behavior in the absence of metal-to-metal contact. The friction curves are presented in Fig. 2(d). The value of μ for CuO compacts against CuO compacts started at 0.75 and reduced to 0.61. Simple abraded spots were formed on the specimens, and the debris was identified as CuO. The value of μ for Cu_2O compacts against Cu_2O compacts started at 0.6 and reduced to a stable value near 0.5. Again simple abraded spots were formed on the specimens, but they were partly encrusted with an unidentified yellow-green stain. The loose debris (Cu_2O) was also yellow-green. The constant values of μ for both copper oxide compacts (Fig. 2(d)) are similar to the constant value of μ for copper against copper (Fig. 2(a)). These results suggest that the constant μ value of copper against copper is a result of the reciprocating sliding of copper oxide on copper oxide. The oxide in the debris resulting from fretting of copper against copper was identified by spot tests and electron diffraction as CuO. Although the constant μ for copper against copper lies closer to that of Cu_2O against Cu_2O than that of CuO against CuO, the difference between all three curves is within the spread normally obtained in friction studies.

Iron oxide compacts: The friction curves obtained for Fe_2O_3 and Fe_3O_4 compacts are presented in Fig. 2(d). The value of μ for Fe_2O_3 compacts against Fe_2O_3 compacts was 0.6 initially, then decreased to 0.51. The fretting produced an abraded flat spot, portions of which showed burnished films of oxide, around which was loose rust-colored debris similar to that produced in the fretting of steel. The value of μ obtained from fretting Fe_3O_4 compacts against Fe_3O_4 compacts started at 0.3, peaked at 0.36 by 5 cycles, decreased to a minimum of 0.29, then slowly increased to 0.45 at 320 cycles and to 0.5 at 600 cycles. Fretting produced a flat spot partially covered with burnished oxide films and with loose rust-colored debris (Fe_2O_3). The appearance of Fe_2O_3 on the specimens which were initially pure Fe_3O_4 and the slow increase in μ from a lower value to a value near that of Fe_2O_3 both show the oxidation occurring during the early stages of fretting of this partially oxidized, nometallic material.

DISCUSSION. Analysis and comparison of the results obtained in the fretting of various materials show that low-amplitude reciprocating sliding produces not just one but several phenomena, all of which exist in ordinary nonreciprocating wear. The phenomena will be discussed separately.

Adhesion. The occurrence of adhesion or cold welding during the first few cycles of fretting was indicated by transfer of material from one surface to the other. Copper suffered the most extensive adhesion and transferred in large amounts to glass, copper, and steel whereas iron transferred in slightly smaller amounts to glass and to pure iron. The start of fretting of steel showed only local adhesion. In the case of hard steel against glass, only a film of oxide was found on the glass.

The extent of adhesion was also indicated by the high initial values of μ obtained, the values ranging from 0.6 for hard steel against hard steel to greater than 1.6 for copper against glass.

Adhesion is considered to be the most important phenomenon observed in these unlubricated fretting runs because it precedes and initiates the other phenomena observed. Its elimination or minimization should prevent or reduce fretting damage.

Plowing. The second phenomenon observed was plowing or scoring of a surface by (1) asperities on the opposing surface, or (2) material transferred to the opposing surface, either as discrete fragments or as films.

Damage by plowing was greatest in the case of copper, a material inherently susceptible to galling. In the case of steel, damage due to plowing was far less evident and occurred only after films of compacted oxide had formed.

The reduction in μ was greatest (for example, 1.65 to 0.6 for copper against glass) for surfaces which experienced the most material transfer and plowing initially.

Formation of debris. The nature and quantity of debris (loose fragments) varied with the materials studied. The fretting of steel produced a large quantity of debris made up primarily of small oxide particles. No metal was identifiable. The fretting of copper produced large metallic debris fragments initially, smaller metal fragments later, then CuO after 100 cycles. Although iron has a greater affinity for oxygen than copper, fretting did not produce loose oxide on iron until after 300 cycles, and even then only in traces.

These results suggest that the occurrence of oxidation during fretting depends on the size of the wear fragments formed as much as the oxidizability of the bulk metal. If a fragment is large, it does not oxidize completely; whereas if the fragment is small, it is likely to oxidize completely.

In most cases where identification was possible, the oxide formed was found to be the final oxidation state of the material; that is Fe_2O_3 for iron, steel, and iron oxide compacts, and CuO for copper. The only exceptions were Cu_2O compacts, which fretted to give Cu_2O powder debris.

Formation of films. The surface films formed in most of the experiments were found to result primarily from the compacting of small wear fragments into clearances in the apparent contact area. Whenever identifiable, the films were found to be oxide but were much thicker than films formed by heating metal surfaces in air. They formed on iron after 50 cycles of fretting and on hard steel in the first half-cycle, particularly when the steel was fretted against glass or hard steel. Compacts of iron oxide powder also formed films during fretting. No film was visible when copper fretted against copper, but a greenish film formed on glass when it fretted against copper. Thus, films form readily during fretting, and the formation is enhanced when the opposing surface is a hard material. Films probably form in other types of wear in the same manner, but in fretting the formation is aided by the low-amplitude reciprocating motion.

The ability of oxide particles to form a film is unusual in view of their commonly accepted hardness or lack of plasticity. However, supplementary experiments have shown that fine dry Fe_2O_3 powder collected from fretting of steel against glass can be pressed to form a film, and further evidence was noted in Ref. 5, where Stott observed the flattening of oxide nodules during experiments with jewel bearings.

In these unlubricated fretting experiments, the films were the source of the loose oxide powder debris. As the real area of contact shifted from one spot to another, portions of the film were relieved of load and disintegrated or sloughed off as oxide debris just beyond the ends of the furrows. The larger fragments which made up the loose metallic debris worked their way out of the contact area without going through the film stage.

CONCLUSIONS. 1. Fretting starts with severe adhesion or cold welding. The adhesion varies with the material combination but is of primary importance because is precedes and initiates the other phenomena observed.

2. In the early stages of fretting, several other wear phenomena in addition to adhesion occur. Their relative importance varies with the materials fretted, and they can occur simultaneously at different points within a contact area. (a) Plowing by surface asperities or by protruding transferred material occurs. The plowing is more pronounced when initial adhesion is greater. (b) The nature and quantity of debris (loose fragments) varies with the materials. Oxide debris is not evident when large wear fragments are produced, whereas oxide debris is evident in a very few cycles if wear fragments are small. (c) Films are formed by compacting small particles into clearances in the contact area. The formation occurs readily if one of the surfaces is hard.

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Section News

Notice to Section Secretaries: To insure early and adequate coverage of your Section's activities, all Section News copy (including Summaries of papers presented, Election of Officers, Photographs, etc.) must be received by the ASLE National Office 1½ months prior to the month of LE publication.

Buffalo. January Meeting. H. O. Walp, SKF Industries, presented a paper entitled "Causes & Prevention of Anti-Friction Bearing Failures," illustrated with slides showing numerous types of ball and roller bearing failures, followed by a Question & Answer period. (Submitted by W. H. Miller, Sec'y).

Chicago. January Meeting. Dr. E. S. Ross, Sun Oil Co., spoke on the subject "Refrigeration Oils."

February Meeting. Ladies Night, featuring Johnny Paul, Clown Prince of Magic; a paper entitled "Science, Industry, and Your Future" presented by P. R. Leach, Jr., E. I duPont deNemours & Co., and a film "Operation Doorstep" supplied by the U. S. Atomic Energy Commission.

March Meeting. L. W. Kalinowski, Sinclair Research Laboratories, Inc., spoke on the subject "Recent Development in Quenching Oils," emphasizing the ability of a quenching oil to transfer heat from the hot metal surface, followed by a Question & Answer period. (Submitted by W. P. Green, Sec'y-Treas.)

Fort Wayne. March Meeting. Election of Officers (See ASLE Directory. Submitted by J. R. Sullivan, Sec'y-Treas.)

Kansas City. March Meeting. C. E. Schmitz (former ASLE President), Crane Packing Co., presented a paper on the subject "Mechanical Seals."

April Meeting. Election of Officers (See ASLE Directory. Submitted by W. R. Johnston, Sec'y-Treas.)

Kingsport. March Meeting. Annual reports of the Chairman and Secretary-Treasurer, followed by two films "Lubrication of Gears" and "The Great Silk Route." (Submitted by J. E. Fleenor, Sec'y-Treas.)

Milwaukee. March Meeting. W. E. Campbell (ASLE 1953-1954 President), Brush Laboratories Co., Div. of Clevite Corp., presented a paper entitled "Solid Lubricants."

April Meeting. D. M. Cleaveland, Bendix Products Div., Bendix Aviation Corp., spoke on the subject "Disposal of Used Lubricants & Cutting Fluids." (Submitted by R. W. Schroeder, Sec'y).

New York. January Meeting. H. Wadlow, Bell Telephone Labs., presented a paper entitled "Micro Qualitative Approach for Solving Lubrication Problems in the Telephone Industry," in which the procedure for obtaining minute lubricants samples from bearings and contact points was described. Using these small samples it is possible to determine many of the physical properties and chemical constituents present, by methods which were developed or standardized in their laboratories.

February Meeting. Dr. D. D. Fuller, Columbia University, spoke on the subject "Air Lubrication—Fact or Fancy," in which he expanded on the information and data published in the December issue of LE. It appears air lubrication offers some promise in certain specialized industrial applications.

A condensed course on Industrial Lubrication Engineering, sponsored by the ASLE New York Section, was begun in February and continued for six consecutive Thursday evenings attended by 94 students of which two-thirds represented oil con-

(Continued on page 168)

ASLE Officers & Directors

ASLE Officers & Directors for 1954-1955. The following Officers & Directors were elected at the ASLE 9th Annual Meeting & Exhibit held in Cincinnati, Ohio, on April 5-6-7, 1954, to serve the American Society of Lubrication Engineers during the 1954-1955 term of office.

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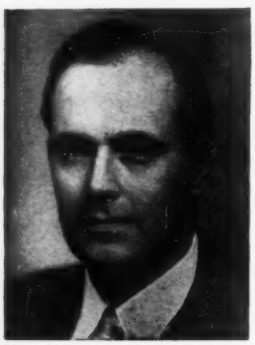

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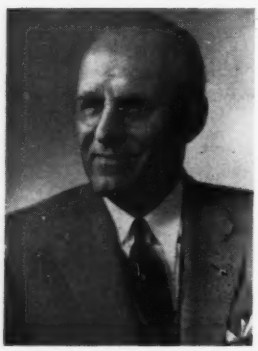

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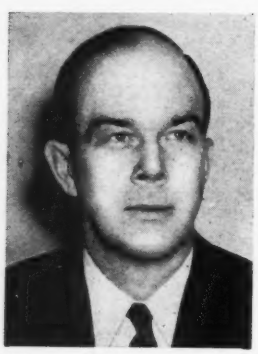

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Twin Cities.....C. D. Johnson, Twin Cities Test. & Engrg., 2440 Franklin St., St. Paul 4, Minn.
Wheeling.....J. A. Martin, 8 Mar-Mary Apt., Wheeling, W. Va.
Youngstown.....J. A. Samuels, The Texas Co., 1103 Marble St., P. O. Box 327, Youngstown, Ohio

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By-Laws.....A. F. Brewer, The Texas Co.
Editorial.....S. K. Talley, Shell Development Co.
Education.....B. G. Rightmire, Massachusetts Institute of Technology
Exhibit Arrangements.....J. D. Lykins, Wheeling Steel Corp.
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W. H. Fowler, Jr. (Chairman Ex-Officio), The Pure Oil Co.
Historian.....W. G. Fatch, Carnegie-Illinois Steel Corp.
Industrial Membership.....W. P. Youngclaus, Jr., ASLE National Office
Industry Relations.....J. P. Critchlow, Gulf Oil Corp.
Membership & Admission.....R. Q. Sharpe, Socony-Vacuum Oil Co.
National Meeting (Annual—Chicago).....A. B. Wilder, E. I. duPont deNemours & Co.
National Meeting Manual.....A. S. McNeilly, Esso Standard Oil Co.
New Sections.....W. P. Youngclaus, Jr., ASLE National Office
Nominations.....W. E. Campbell, Brush Labs. Co., Div. of Clevite Corp.
Program (Annual Meeting—Chicago).....J. L. Finkelmann, The Warren Refining & Chemical Co.
Research & Projects.....E. M. Glass, Hq. Wright Air Development Center

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Lubrication Equipment.....A. F. Brewer, The Texas Co.
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Physical Properties of Lubricants.....M. L. Langworthy, The Texas Co.
Principles & Practices of Economic Lubrication.....K. S. Smiley, E. I. duPont deNemours & Co.

ASLE PROGRESS REPORT FOR 1953-1954

by W. E. Campbell*

During the past year our Society has continued the vigorous growth which has characterized its activity from the start. This progress has been made possible by the support of the members of the Society to the Board of Directors, the National Committee Chairmen, and the National Office Staff. It is my pleasant duty as their representative to present you in this message a review of the highlights of this growth.

MEMBERSHIP. Our membership has continued to increase at a substantial rate, which is slightly higher than that for the last year, and stood at 2,416 as of April 1st. Your Membership Committee has been very active this year, having compiled a tentative plan of procedure for section membership chairmen and forwarded this to sections for comments. It is planned, during the coming year, to make a Membership Committee Manual available to section chairmen, which will be based on this tentative plan and on the advice received from the sections. This manual will provide sections with a detailed plan on the setting up and functioning of an effective membership committee.

During the year a system for obtaining new members was initiated requiring present members to write, on a stamped card addressed to the National Office, the name of one friend who would benefit by and might be interested in membership in the Society. Your Administrative Secretary then wrote an invitation to membership to the suggested party. Where this plan has been followed and cards have been filled in, it has been very effective in securing new members. However, only a small fraction of our membership has co-operated in this matter. It is my opinion that if this plan, as well as the others to be advocated by the Membership Committee, are effectively supported by the members, our already satisfactory growth rate can be substantially increased.

During the year two new industrial members have joined the Society — American Brake Shoe Co., New York, and Southwest Grease & Oil Co., Wichita, Kansas. As our Society grows and provides additional services, it has more and more to offer industrial members. There is a tremendous potential yet untapped in this field. Members can help by sending in prospective industrial members, with the name of the official representative, to the chairman of the Industrial Membership Committee, Mr. Wm. P. Youngclaus, Jr.

FINANCES. The copy of the Annual Audit mailed recently to all members, together with a copy of the 1954 Budget, shows your Society continuing to maintain its sound financial condition. I am glad to report that the Board of Directors, at its meeting Saturday, April 3, voted to increase the Reserve Fund by an additional $8,000, the largest contribution to this fund ever made by the Society. This emergency fund, which can only be used after consent of a majority in the Board of Directors, now stands at $27,300 in round numbers.

SECTIONS. Two new sections have been established during the year — the Montreal Section and the Houston Section — bringing the total number to 29. Active interest is being displayed in the establishment of several others.

ANNUAL MEETING PROGRAM. The increase in strength of our Society is reflected in the variety and comprehensiveness of our annual meeting program. Last year it reached the limit of coverage which can be obtained in three concurrent sessions. This year, the successful principle of unified concurrent sessions has been continued and the same broad coverage has been achieved. In addition, a five session course in the Elements of Lubrication Engineering for maintenance engineers was given this year to provide a new service to industry. This course enabled a plant man to obtain a working knowledge of lubrication engineering during the three days of the meeting, and to visit the exhibits as well. In view of the increasing interest in our annual meeting on the part of technical men, it will be necessary for our Program Committee to be more and more selective in the choice of papers for future meetings in order to restrict the sessions to a manageable size and number.

EDUCATION. During the year two Society-sponsored short courses in Lubrication Engineering were held in the summer in major universities —Massachusetts Institute of Technology and Northwestern University. Both were highly successful.

The Philadelphia Section continued its pioneering efforts in the education field by sponsoring two courses. One, on the college level, for engineering and research personnel, was co-sponsored by the Franklin Institute in the fall of 1953. The other, on the more elementary level of previous courses, was given in February and March of 1954. Following in Philadelphia's footsteps, and helped greatly by the manual "Proceedings for Conducting Training Courses in Lubrication Practices for Local Sections" prepared for the Education Committee, the New York Section put on a six-session Lubrication Course during February and March of 1954. This course was highly successful, attracting 94 registrants, gaining 18 new members for the Society, and netting a substantial profit for the section. Similar courses are being planned for the coming year by several sections. In addition to these courses, educational activities were sponsored by the Cleveland, Los Angeles, Milwaukee and Boston Sections.

The experimental Education Course which was run concurrently with the technical sessions at the Annual Meeting in Cincinnati was conceived late and was not as well publicized as will be possible in the future, but was highly successful, attracting 115 students. It evidently fulfills a real need and will become an important service at future annual meetings.

During the past year a final set of standard symbols was published. This will now be submitted to the American Standards Association. A set of definitions of lubrication terms has been through

*(ASLE 1953-1954 President) Brush Laboratories Co., Div. of Clevite Corp.

several revisions during the past two years and will be published for comments and criticism shortly.

Activity has continued in vocational training.

Work on the production of educational monographs on the plant-maintenance engineer's level has continued, but at a rather slow pace. A noteworthy service was, however, performed in the issuance free to members of a monograph entitled **"Interpreting Service Damage in Rolling Type Bearings."** This monograph contains 88 excellent pictures of different types of bearing damage and should be of tremendous help to lubrication engineers.

EDITORIAL. The joint activity of the Editorial Committee and the National Office Staff has resulted in further improvements in our magazine, **Lubrication Engineering.** Although the yearly number of pages remains unchanged, the number of main-text articles which has appeared has shown a steady increase — 35 articles were published in 1953 compared with 27 in 1952 and 22 in 1951. It should be further noted that this increase has been accompanied by an increase in the quality standards which the papers must meet. These improvements in quality and quantity of technical material reflect the growing strength of the Society and the improved services which it is thus rendering to its members and to industry.

During the past year attention has been turned also to improving further the readability of the magazine. Advice of experts in and out of the Society is being sifted and applied in a continuing program of improvements. In line with this improvement program a set of "Instructions for Authors" has been drawn up which sets minimum style standards for authors and prospective authors. It is expected that this whole program will be completed by the end of 1954 when a set of minimum standards will be formulated and made the basis for future publication.

That these improvements are being appreciated by technical people is attested by the fact that for the first time in our Society's history we are out of stock of back numbers of two issues — June and August 1953. I can confidently predict that by 1955 we will have a magazine which is equal in all respects to the best comparable publications of any of the other technical societies, with consequent benefits to our members and to industry.

SPEAKERS BUREAU. The Speakers Bureau which was initiated last year by the Research and Projects Committee has continued to function this year as a subcommittee of the National Program Committee. The results of its survey for the coming season will be completed shortly and were made available to Section Chairmen by the first of May.

THE TECHNICAL COMMITTEES. The Technical Committee organization of your Society has continued to perform its direct service to industry by answering lubrication problems requiring considered advice of a group of experts. During the year twenty-six requests for information from all over the world were answered by the various technical committees.

Another activity aimed at giving better service to our members was the Member Interest Survey sent out during the summer of 1953. Valuable information was obtained regarding the interests of our members which will be used in the planning of

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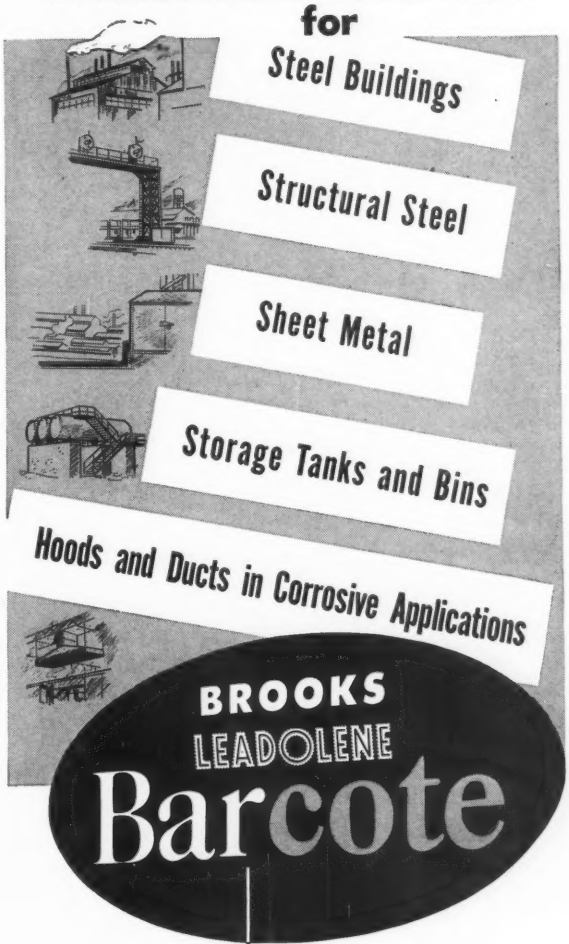

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annual meeting programs and technical committee activities. A preliminary analysis of the results appeared in the April issue of **Lubrication Engineering.** The ASLE Advancement Committee will continue the analysis during the year in order to extract full benefit from the survey.

A major activity of the Technical Committees has continued to be the solicitation and review of papers for the Annual Meeting Program and for **Lubrication Engineering.** The success of the Annual Meeting was due largely to the combined efforts of these committees, the Annual Meeting Committee, the Program Committee, and the National Office Staff.

It should be emphasized here that membership on these technical committees is available to every member of the Society. In fact, every committee chairman welcomes new members enthusiastically. There is no more rewarding way of gaining the full benefits of Society membership than service on these committees.

ANNUAL MEETING COMMITTEE. The Cincinnati Annual Meeting Committee has continued the fine tradition set by earlier committees in laboring conscientiously all year to provide every facility that makes for a successful meeting. A record registration of 1270 reflects the success of their efforts.

A committee consisting of a group of former annual meetings chairmen has worked during the year to bring the annual meetings' manual up to date, thus providing a guide for the committee chairmen of future meetings.

OTHER COMMITTEES. The space available does not permit a summary of the activities of every committee. Suffice to say that many other committees have worked steadily through the year at important tasks for the Society. Some of these committees, whose efforts have helped in the growth of the Society, are the Awards Committee, the Nominations Committee, the By-Laws Committee and the Research & Projects Committee.

The Industry Relations Committee, whose function is to help bring to the attention of industry the valuable services our Society is rendering, has been reconstituted this year. This committee held its first meeting in Cincinnati where an important program was planned.

NATIONAL OFFICE. Our genial Secretary, Wm. Youngclaus, Jr., has continued to improve the efficiency and smooth running of the National Office. Mr. Kluge has been the executive officer who has engineered the improvements in the magazine. Miss Josephine Lapointe and Miss Helen Shinovich have continued to assist with willingness and efficiency.

During the year the Staff has moved into new, more commodious and comfortable quarters in the Western Society of Engineers Building which provide more fitting reflection of the growing prestige of our Society.

It gives me real pleasure to announce that the employee incentive scheme worked out last year by your Finance Committee was put into practice this year and resulted in a substantial improvement in the Christmas bonus available to the staff.

SOCIETY CLASSIFICATION STATUS. Another improvement in the Society's prestige has resulted from a change in its Classification Status by the U. S. Government. The Internal Revenue Bureau has granted our request for change of status to

Section 101.6, Scientific and Educational, Not For Profit Corporation. Up to the present we have been classified in Section 101.7 as a Not For Profit Group along with trade associations. This change puts us in the same class as other engineering and scientific societies and allows all payments to ASLE as deductions for Internal Revenue purposes.

CONCLUSION. I wish to thank every one of you for the marvellous backing I have been given during the year. The year's work for the Society has been an inspiriting and rewarding experience which I shall treasure through the years. This has been made possible by your co-operation and by the knowledge that we are working together in the service of society.

(Lube in the News, from page 142)
transfer pumps, and through power operated barrel pumps to a complete lubrication department on wheels. The film, and a 12-page booklet 'Five Plans for Better Plant Lubrication' graphically emphasizing each of the five plans, are available to plant maintenance and production men through the nationwide Alemite distributing organization. For complete details, write: Alemite Div., Stewart-Warner Corp. (LE10/3), 1828 W. Diversey Blvd., Chicago 14, Ill.

Oven Chain Lubricator. A compact oven chain lubricator that facilitates lubrication of hard-to-reach chains, rollers and pins, and at the same time safeguards the operator from burning his hands, is described in a new 2-color bulletin recently released. Available with or without a 4-castered dolly and designed to fit directly to a standard 5-gal. can of lubricant, the unit consists of pump, ¼-h.p. motor, 2-ft. applicator, 9-ft. hose and slow speed mechanical agitator. (The latter device produces a homogenous mixture of the graphite and carrier, even though the pail has not been used for some time, and eliminates the spillage and waste of conventional paddle mixing.) For copies, write: R. G. White, Engineering Co. (LE10/3), 1338 Atlantic Ave., Brooklyn 16, N. Y.

Lapping Shoulder Faces of Shafts. A new method for lapping shoulder faces of shafts has been developed by providing the lap plate with a series of annular grooves to accomodate the stem of the workpiece and allowing the shoulders to 'ride' the top of the lap plate during the cycle. The fuel pump parts are pre-loaded into a special brass cylindrical work holder which has been bored out slightly over-size to the diameter of the workpiece. (These special work holders provide the necessary weight and needed balancing properties.) The adjustable roller guides located at the base of the conditioning ring guide stems are so located to the perimeter of the work holder that the parts being lapped will be held in proper position. (Ball bearing races in the guides reduce friction to a minimum and the work is free to rotate in its own orbit on the lap plate.) To overcome the amount of wear caused by the work on the lap plate the conditioning rings are spring loaded, providing a greater downward force of the conditioning rings on the lap plate. For further information, write: Crane Packing Co. Dept. LEG (LE10/3), 1800 Cuyler Ave., Chicago 13, Ill.

'Aro-Pak,' a completely new air-primed portable lubricator (suitable for many uses among industrial plants, mining companies, fleet owners, road contractors, and other users of lubricating equipment) has been announced that enables the operator to use air power instead of muscle in lubricating complicated machinery or hard-to-reach fittings. Consisting of a cylindrical tank holding 5 lbs. of grease, a handy carrying strap, hose and control nozzle, no compressor is needed enabling the user to lubricate fittings with simple one-hand operation — even in extreme cold. Weighing only 15 lbs. filled, other features include visual grease level indicator, volume control nozzle, full swiveling, with pressure booster feature, and one year guarantee. Price

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As an indication of the growing importance of **Lubrication Engineering,** the demand for extra copies has increased sharply and the supply of back issues for June & August '53 has been exhausted. **To help fulfill numerous requests, ASLE will pay 50c per copy for the first 100 copies of the June & August '53 issues of LE returned to the National Office.**

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ASLE 9th Annual Meeting

PREPRINTS AVAILABLE

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_____**Applications & Limitations Of Centrifuges As Used In The Reclamation Of Industrial Petroleum Products,** by K. D. Reed, The DeLaval Separator Co.

_____**Engine Bearing Design Today,** by J. B. Bidwell, General Motors Research Laboratories

_____**Filters — Their Function & Application,** by J. R. McCoy, Honan-Crane Corp.

_____**Industrial Plant Waste Disposal Problems & Their Solution,** by J. W. Townsend, Consoer-Townsend & Associates

_____**Journal & Thrust Bearing Practices On Large Rotating Electrical Machines,** by R. A. Baudry & B. B. Winer, Westinghouse Electric Corp.

_____**Laboratory Test For Evaluation Of Metal-Forming Lubricants, A,** by R. S. Barnes & T. H. Cafcas, Standard Oil Co. (Ind.)

_____**Lubrication Systems For Heavy Closed Die Forging Presses,** by W. J. Polny, Loewy Construction Co., & R. G. Sturm, Alabama Polytechnic Institute

_____**Reclamation Of Industrial Petroleum Products,** by C. H. Palmer, General Motors Corp.

_____**Reclamation Of Used Industrial Wash Solvents By Distillation,** by J. H. Hills, Hills & Morrow

_____**Solid Type Journal Bearing In Railroad Freight Service,** by E. S. Pearce, Railway Service & Supply Corp.

_____**Wax Coolants & Heat Dispersion,** by F. C. Kraatz, S. C. Johnson & Son, Inc.

_____**Wire Drawing Lubricants — From Raw Materials To Finished Compounds,** by L. Salz, Magnus Chemical Co., Inc.

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(Current Literature, from page 150)

No. 6, Dec. 1953, pp. 104-107.

Natural and synthetic rubbers, silicone elastomers, and certain plastics meet the exacting requirements demanded in liquid and gas-tight seals.

Consultation Service for Insulating Oils, by Anon.; Canadian Chemical Processing, Vol. 37, No. 13, Dec. 1953, pp. 78 81.

The Westinghouse Oil Consultation Service has been established to assist the user in efficiently carrying out a program of preventive maintenance in connection with oil deterioration of interest to those concerned with the manufacture and operation of oil field equipment.

What Should be Done to Protect Engines?, by J. A. Boatman; World Oil, Vol. 137, No. 6, Nov. 1953, pp. 122, 124, 126, 134.

Rules for maintenance of drilling engines are discussed. Practically all heavy duty gas and diesel drilling engines now use additive type or compounded oil. Suitable lubricating oils are discussed.

New 'Filtrex' Process, by Anon.; Soap & Sanitary Chemicals, Vol. 29, No. 11, Nov. 1953, p. 87.

The 'Filtrex' process combines the steps of extraction, filtration and wash-

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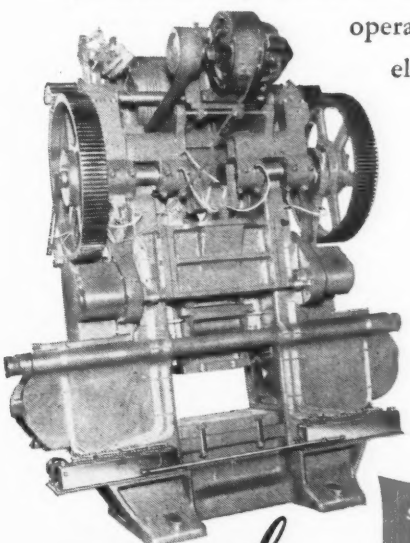

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ing. Flexibility of operation, easy changeover from one oil to another, economy in cost and space, and economical solvent recovery are among the advantages claimed.

Problems of Rheology and a New Viscometer, by W. Heinz; Fette Und Seifen Anstrichmittel, Vol. 55, No. 10, Oct. 1953, pp. 719-721.

The factors controlling the flow of fluids are discussed. A new viscometer has been developed, the 'Visko-Waage' (the visco-scale). This is an adaption and improvement of the Hoppler viscometer. Details of the apparatus and a drawing of it are given.

Three Accelerated Corrosion Tests for Materials & Finishes, by S. Tour; Materials & Methods, Vol. 38, No. 5, Nov. 1953, pp. 110-113.

Although simulated service tests cannot replace actual corrosion service tests, they are useful when corrosion resistance must be evaulated in a relatively short time. The alternate condensation test, the wear-corrosion test, and the aerated sea water test are described.

Plastics Processing, by Anon.; Lubrication, Vol. 39, No. 11, Nov. 1953, pp. 129-140.

In the processing of plastics, whereby the raw powder is transformed into molded products, sheets, tubes, or rods, equipment such as hydraulic presses, extruders, calenders and internal mixers are employed. These machines must operate continuously with as little downtime as possible. Continuous operation depends upon satisfactory lubrication. Lubrication requirements for this type of equipment are considered.

(Section News, from page 159)

sumers. (Submitted by E. Landau, Treasurer & Publicity Committee Chairman).

Northern California. March Meeting. Lt. (jg) E. L. Saul & Chief Machinist Mate R. C. Harrison, Pacific Reserve Fleet, presented a paper entitled "The Preservation & Reactivation of Machinery in the Navy Moth Ball Fleet," in which the general techniques employed in the preservation of Naval vessels and their complicated machinery in the Moth Ball Fleet were discussed, with particular emphasis on the use of thin film rust preventive compounds and the use of dehumidified air in combating machinery deterioration, and on the reactivation of main propulsion equipment. The paper was followed by a film entitled "Dehumidification" portraying the techniques employed in this method of equipment preservation.

April Meeting. R. Q. Sharpe, Socony-Vacuum Oil Co., Inc.,

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spoke on the subject "Hydraulic Systems—Their Care & Operation," covering the trend in hydraulic system design and its influence on production in industrial plant operation. The effect of these trends on the individual properties of hydraulic fluids, and the steps required in the development of petroleum fluids that possess these properties, was covered, with the methods of evaluating these fluids in the laboratory and their correlation with field performance outlined. (Submitted by R. H. Decker, Sec'y-Treas.)

St. Louis. January Meeting. Panel Discussion on "The Testing of Petroleum Products and Interpretation of Test Results," with O. A. Blatter, Union Electric Co.; R. C. Wilbur, Shell Oil Co.; W. K. Oliver, Socony-Vacuum Oil Co.; and Dr. H. H. Zuidema, Shell Oil Co. Research Lab., as Panelists.

February Meeting. A joint meeting with ASME, MSPE, and the Engineers Club of St. Louis, featuring A. VanPraag, Jr., Consulting Engineer, who discussed "The Relationship of the National Society of Professional Engineers to Other Engineering Organizations." (Submitted by G. L. Stetson, Vice-Chrmn.)

Twin Cities. March Meeting. E. L. H. Bastian, Shell Oil Co., presented a paper entitled "Metal Working," covering cutting fluids and applicators, drawing and forging compounds, hot and cold rolling oils, ferrous and non-ferrous metals, and heat treating media.

April Meeting. C. J. Boner, Battenfeld Grease & Oil Corp., spoke on the subject "Lubricating Greases." (Submitted by C. D. Johnson, Sec'y).

(Personals, from page 154)

of lubrication subjects, will be held **October 18 & 19, 1954,** at the Lord Baltimore Hotel, Baltimore, Md. (This Conference supersedes the Symposium on Synthetic Lubricants which was originally planned for October 18 & 19, 1954, and is being postponed to a later date.)

Acheson Colloids Co. has announced the promotion of **A. T. Olsson** from Sales Engineer, De-

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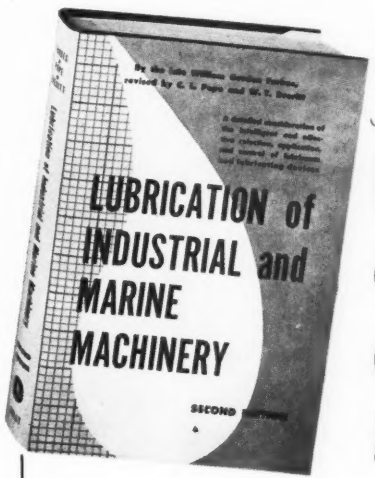

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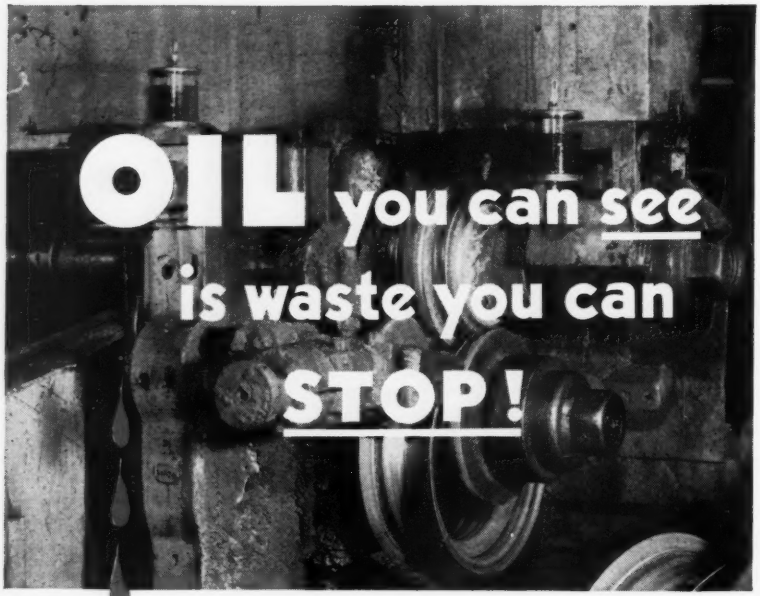

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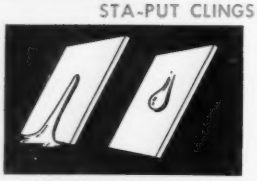

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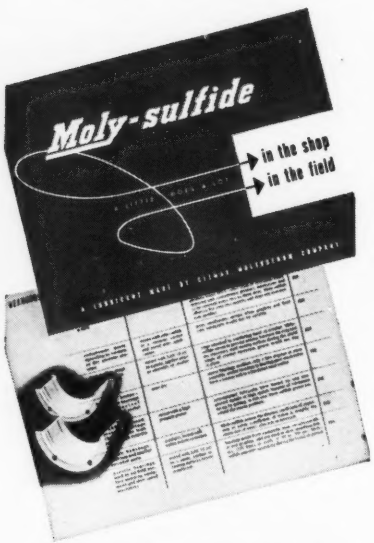

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troit, to Assistant to the Sales Manager, with headquarters at the main office in Port Huron, Mich.

R. F. Duncan, ASLE Chicago Section, has been made Manager of the Package Products Div. of Calumet Refining Co., Chicago, where he is also Secretary-Treasurer and a member of the Board of Directors.

(Patent Abstracts, from page 146)

668,145, by G. S. Ronay, assignor to Shell Development Co.

A lubricating oil base having incorporated therein from 0.01 to 0.5% by weight, which amount is insufficient to modify the viscosity of the lubricating oil base, of clay modified by an organic cationic material selected from amines and quaternary ammonium compounds so as to render said clay oleophilic.

Metal-Working Compositions, Patent #2,668,146, by T. H. Cafcas & A. W. Lindert, assignors to Standard Oil Co.

An improved emulsifiable soluble oil composition comprising from about 45% to about 95% of a hydrocarbon oil, from about 5% to about 40% of an emulsifying agent selected from the class consisting of an alkali metal, ammonia and amino soap of a perferentially oil-soluble sulfonic acid, and a sodium, potassium, ammonia and amino soap of a naphthenic acid, and from about 0.01% to about 5% of a tannic acid.

Ester-Type Synthetic Lubricants, Patent #2,668,848, by M. B. Neuworth, assignor to Socony-Vacuum Oil Co., Inc.

The non-resinous reaction product obtained by reacting an adipic acid monoester having the formula, $ROOC(CH_2)_4COOH$, wherein R. is a branched-chain aliphatic radical containing between about 6 and about 20 carbon atoms, with a glycol reactant selected from the group consisting of an ethylene glycol having the formula, $H(OCH_2CH_2)_nOH$, wherein is an integer varying between one and six, and thiodiglycol, in a molar proportion of about 2:1, respectively.

Bitumen and Polyvalent Metal Hydrocarbon Oil Sulfonate Composition and Process of Making Same, Patent #2,669,525, by D. W. Bransky, J. A. Bolt, M. W. Stacy, and M. Feller, assignors to Standard Oil Co.

The composition comprising a bitumen hydrocarbon and from about 0.5% to about 5% of a mixture consisting essentially of from about 20% to about 30% calcium sulfonate derived from sulfuric acid sludge resulting from the treatment of hydrocarbon oils with sulfuric acid of at least about 95% strength, from about 35% to about 60% of a liquid solvent having a boiling point above about 220 F. and an aromatic content of at least about 40%, and from about 4% to about 8% of an alkyl carbinol having from 2 to about 16 carbon atoms, not more than about 35% water and from about 5% to about 10% hydrocarbon oil other than said liquid solvent.

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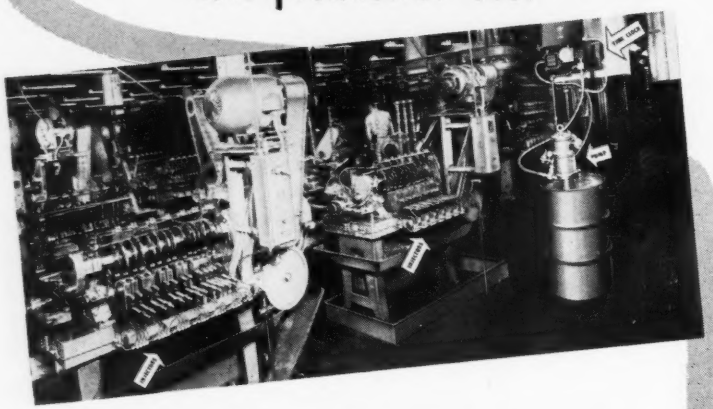

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Lubricant, Patent #2,669,543, by Sabine Hirsch, assignor to Cargill, Inc.

A lubricant, comprising mineral oil, and a soap mixture formed by reacting a saponifying agent with the product, as such, resulting from the oxidation of heavier aliphatic hydrocarbons varying in consistency from liquid to solid at normal temperature and which have been oxidized to produce a saponification number of at least 155, and forming with the mineral oil a solid to semi-solid grease of a substantially stable consistency.

Benzothiazyl Sulfenamides in Lubricants, Patent #2,669,544, by Warren Lowe, assignor to California Research Corp.

A lubricant consisting essentially of a major proportion of a silver corrosive sulfur-containing lubricating oil composition, and from about 0.01% to about 10%, by weight, of a benzothiazyl sulfenamide.

Sulfuration of Mineral Oil, Patent #2,669,560, by E. H. Sperry, assignor to Sun Oil Co.

The method of sulfurating mineral lubricating oil which comprises: contacting mineral lubricating oil in liquid phase at about 250-400 F. with elemental sulfur in the presence of elemental iodine.

Cutting Oils, Patent #2,670,330, by D. P. Clark, Jr., assignor to Gulf Research & Development Co.

A petroleum base cutting oil composition consisting essentially of a stable solution of flowers of sulfur and

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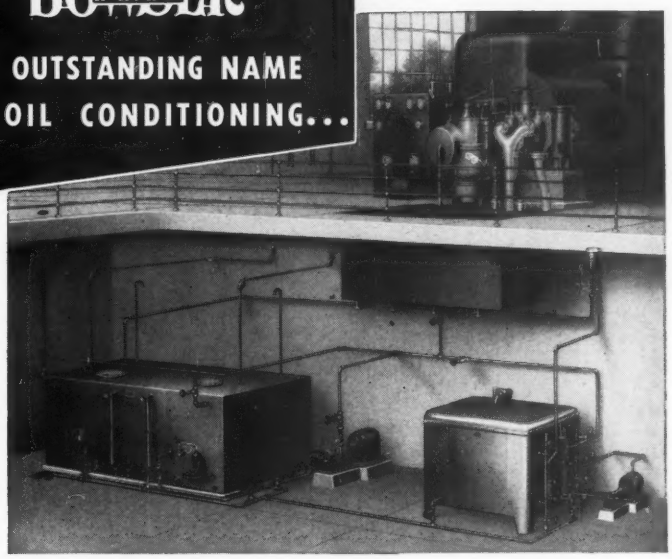

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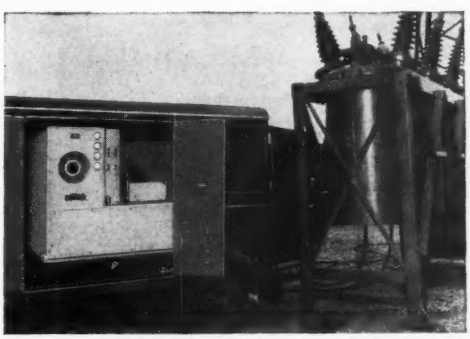

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a phosphatide in a mineral oil having an aniline point below about 85 C., said solution containing a greater amount of dissolved sulfur than can be dissolved in the mineral oil in the absence of said phosphatide.

Low Pour Point Lubricants, Patent #2,671,051, by R. J. Moore, assignor to Shell Development Co.

A normally fluid lubricating composition comprising a major amount of a waxy hydrocarbon lubricating oil having a viscosity between about 50 and about 250 SSU at 100 F., the waxy portions of said oil predominating in normal aliphatic hydrocarbon waxes having an average chain length of at least 20 carbon atoms per molecule and as a pour point depressant therefor from about 75% to about 150% based on the weight of said waxes of at least one extraneous hydrocarbon wax bearing a cyclic end group on an aliphatic hydrocarbon chain, the latter differing from the average normal aliphatic hydrocarbon wax chain length by no more than about 4 carbon atoms.

Rust Preventive Grease Containing a Polyvalent Metal Sulfonate and a Wax Oxidation Product, Patent #2,671,759, by G. W. Eckert & T. W. Langer, assignors to the Tevas Co.

A lubricating grease adapted for the lubrication of high-speed ball and roller bearings under severe rusting conditions comprising essentially a mineral lubricating oil as the predominant constituent thickened to a grease consistency with about 7-25% by weight of the lithium soap of a saponifiable material consisting of a major proportion of a soap forming hydroxy fatty material and a minor proportion of a non-hydroxy soap forming saturated higher fatty acid, said lubricating grease containing about 0.7-1.05% by weight of a calcium salt of mahogany sulfonic acids, about 2-3% by weight of a synthetic acid product having a neutralization number from about 50 to about 100 obtained by the partial oxidation of petroleum wax, and about 2-3% of tallow, said grease being capable of preventing substantially any rusting of steel panels in the salt spray rusting test for periods up to 100 hours.

Lubricating Oil Compositions, Patent #2,671,760, by W. S. Port, J. W. O'Brien & Daniel Swern, assignors to the United States of America as represented by the Secretary of Agriculture.

A lubricating oil composition having an improved viscosity index, comprising a lubricating oil having incorporated therein a linear heteropolymer having a molecular weight of about from 5,000 to 100,000 and having been prepared by polymerizing a mixture containing, as polymerizable components, monomeric vinyl acetate and monomeric vinyl palmitate.

Flushing Oil, Patent #2,671,761, by M. L. Kalinowski & Morris Feller, assignors to Standard Oil Co.

A flushing oil which consists essentially of about 2% to 98% by volume of an aromatic solvent boiling in the range of 350 to 650 F., having an A.P.I. gravity in the range of 10 to 20 degrees, and consisting chiefly of poly methyl benezene, polycyclic aromatics and mono methyl and poly methyl polycyclic aromatics in combination with about 98% to 2% by volume of an "ebony fat," which "ebony fat" is a propane-insoluble residue of a crude fatty material which residue constitutes only about .1 to 2% of said crude fatty material.

Rust Preventive Compositions, Patent #2,672,444, by J. I. Wasson & D. L. Bonham, asignors to Standard Oil Developmet Co.

A composition consisting essentially of hydrocarbon oil base lubricant containing 0.1 to 10% by weight of monooleate ester of polyglycerol which is predominantly diglycerol, said polyglycerol being prepared by heating glycerin to a temperature within the range of about 225 to 250 F. for a period of time sufficient to increase its viscosity substantially, 0.1 to 10% of metal sulfonate, and 0 to 10% of degras.

Transformer Oils, Patent #2,672,445, by W. T. Stewart, C. D. Newman & N. W. Furby, assignors to California Research Corp.

A lubricating oil composition consisting essentially of a major portion of a low molecular weight alkylene oxide liquid polymer of lubricating viscosity, which polymer is substantially free from groups normally reactive with selenides and dihydroxyanthraquinones, and a small amout, sufficient to increase the resistance of the lubricating oil of oxidation, of a selenide having at least one aliphatic group of at least 10 carbon atoms attached to the selenium atom, to which lubricating oil composition is further added a synergist for the selenide, said synergist being a dihydrxyanthraquinone which is present in the lubricating oil composition in an amount from about 0.0001% to about 1.0%, by weight.

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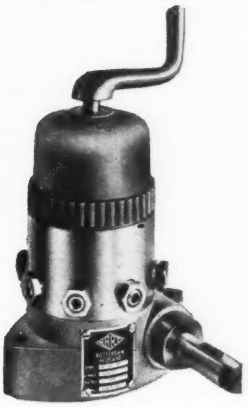

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Advertisers' Index

Acheson Colloids Co. 125
Alemite Div., Stewart-Warner Corp. 128
Apex Motor Fuel Co. 165
Aro Equipment Corp., The 171
Attapulgus Minerals & Chemicals Corp. 129
Ayerst Laboratories 168
Baroid Sales Div., National Lead Co. ..... 126 & 127
Bowser, Inc. 173
Brooks Oil Co., The 163
Burns Laboratories, Inc. 164
Carbide & Carbon Chemicals Co. 173
Classified 164
Climax Molybdenum Co. 170
Farval Corp., The ..... (Inside Back Cover)
Grafo Colloids Corp. 166
Hodson Corp., The ..... (Back Cover)
Honan-Crane Corp. 130
Houghton & Co., E. F. 170
International Lubricant Corp. 122
Ironsides Co. 135
Johnston Equipment & Supply Co. 175
Lincoln Engineering Co. 172
Lubriplate Div., Fiske Bros. Refining Co. 175
Madison-Kipp Corp. 132
Manzel Div. of Frontier Industries, Inc. 167
Morgan Construction Co. 123
Norgren Co., C. A. 133
Purolator Products, Inc. 134
Scientific Publications 167
Shell Oil Co. 124
Sinclair Refining Co. 174
Sun Oil Co. 131
Swan-Finch Oil Corp. 175
Trabon Engineering Corp. ..... (Inside Front Cover)
Trico Fuse Mfg. Co. 165
Wiley & Sons, Inc., John 169

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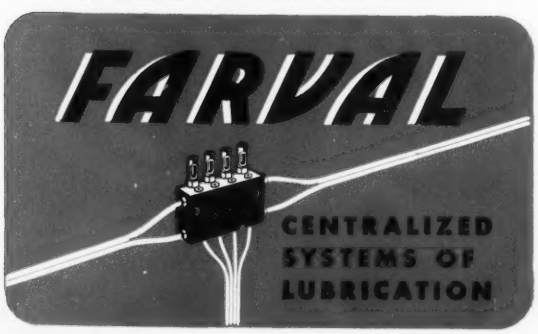

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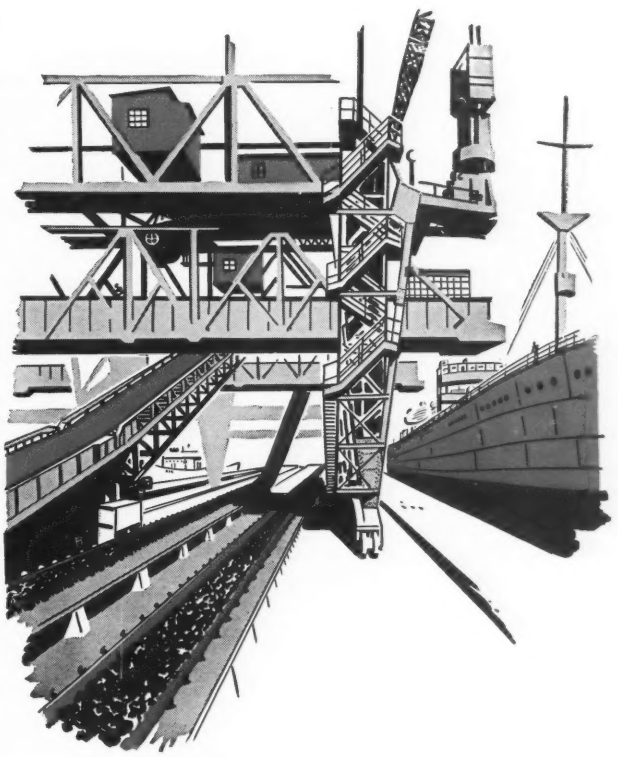

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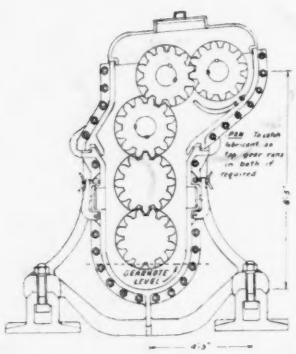
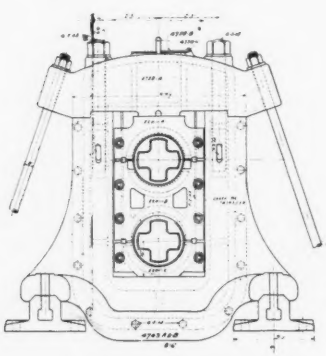
IN THE LABORATORY

IN THE FIELD



GEARKOTE Installation

IN THE PLANT



METALICOIL Installation

The HODSON CORPORATION

Lubrication

5301-11 WEST SIXTY-SIXTH STREET

CHICAGO 38, ILLINOIS

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